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DIVISION OF WATERSHED MANAGEMENT RESEARCH

Semiannual Report

PSW-6 microclimate

U. S. DEPARTMENT OF AGRICULTURE

FOREST SERVICE

April - September 1959

USE OF THIS REPORT

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CENTRAL STATES FOREST EXPERIMENT STATION

April 1 - September 30, 1959

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Division of Watershed Management Research
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Washington Office

The Washington Office has been busy although we find it a bit difficult to hold up any trophies and say this is what we have done and won. Inspections, meetings for special problems, the Forestry Research Advisory Committee, and the International Association of Scientific Hydrology have been a part of our activities.

Meetings of International Association of Scientific Hydrology

The climax of the summer season was the trip Herb Storey and Pete Martinelli (RM) made to the meeting of the International Association of Scientific Hydrology held at Hannover-Münden, Germany, September 8-14. Others attending from U.S.A. included our old friend Hal Wilm, now Commissioner of Conservation for the State of New York, Lloyd Harrold, ARS, Coshocton, Ohio, and Max Kohler, Weather Bureau, Washington, D. C. The program consisted of two symposia: (1) Water and Woodlands and (2) Lysimeters. Of the 35 papers prepared for the sessions on Water and Woodlands, eight were from the United States and all prepared by Forest Service personnel. The United States had four out of 17 papers in the session on lysimeters and two of those by Forest Service people. Russia was on the program for about the same number of papers but no one showed up at the meetings to present them. They are, however, published in the proceedings as Publications No. 48 (Water and Woodlands) and No. 49 (Lysimeters), Symposium of Hannoversch-Münden, Vol. I and II, International Association of Scientific Hydrology.

Herb and Pete found these meetings to be very worthwhile, and made some interesting contacts among the representatives from 17 countries. The meetings were over-programmed, and if the Russians had shown up the sessions would have had to go on a 24-hour schedule to be completed.

Tour of Alpine Research Stations in Europe

Herb and Pete took advantage of their presence in Europe to visit the snow and avalanche research being done at Grenoble in France, Davos in Switzerland, and Innsbruck in Austria. The work at Grenoble is under the general direction of the forestry research station and the School of Forestry and Waters at Nancy, France. The principal activities are torrent control, avalanche prevention and reforestation. The research is something of a trial-and-error variety wherein they tackle a serious torrent or avalanche problem area with structures and trees and keep on trying one type or another until they gain control of the problem. There is usually a great deal of back-breaking labor involved although in recent years a lot of materials are brought in by helicopter. New structures are added and the old ones repaired, as needed. Costs are very high.

The avalanche warning system used in France was reviewed. Electrique de France collects information from cooperators and makes forecasts at weekly or more frequent intervals. The French believe that (1) amount of new

snow, (2) wind action, (3) air temperature, and (4) structure of snow in the pack are the most important things in determining avalanche hazard. Protection from avalanches is accomplished in three further ways: (1) stretching flexible nylon nets across the slope to hold the snow in the accumulation zone, or (2) by building rigid structures at staggered settings across the path to hold the snow in place, and (3) by "shooting" avalanches off the mountain at opportune times. The French are much interested in studies of vegetation to stabilize the paths of avalanches.

At Davos, Switzerland, there are 25 people engaged in snow and avalanche research. They are working on (1) weather, snow cover and avalanches; (2) construction for avalanche protection; (3) reforestation as a means of avalanche protection and prevention; (4) hailstone formation in controlled climate; and (5) crystallogrphy. The Research Institute maintains an excellent machine shop where they fabricate many of the special instruments needed in the research. Detailed studies are being made of water equivalent of snow, hail development and crystal structure, mountain wind patterns, and structures and reforestation to reduce avalanche hazard. Wind, structures and reforestation are incorporated in a well designed field study of avalanche control.

At the Experiment Station for Avalanche Prevention, Innsbruck, Austria, studies of plant ecology are being made to develop simplified guides to tree planting procedures, as part of the total effort to control torrents and prevent avalanches. The Innsbruck group is working with key trees and shrubs and even lichens and mosses to determine the factors of environment that are limiting to growth. Some work is being done with snowfences to control snow depth.

The Austrians have begun their studies of avalanche prevention more recently than other alpine countries and seem to be more concerned about economical methods. Rather than treating the source areas in many cases they attempt to dissipate the volume and force of the avalanches as they come down the mountain.

Storey and Martinelli also visited the Swiss Institute of Hydrology at Zurich and discussed the program of work which includes studies in glaciology. The travelers are preparing an informal report of their trip and you will get more details from that.

Data Processing

Partly as followup to the Division Chiefs' meeting at San Dimas last winter, Herb Storey and Ted Osborne visited the Pacific Southwest Station to discuss the development of a program for processing and analyzing the accumulation of hydrologic data through the use of high-speed computers. The unanimous conclusion was that these data could be programmed for analysis with considerable saving of time and cost over conventional analytical methods. In addition, analyses are possible that would be impractical with the old methods. The Station, with Bill O'Regan taking the lead, will move ahead with the programming of the San Dimas data, and their experience will undoubtedly be valuable to other Stations with similar data problems.

Reports for Senate Select Committee

Clark Holscher has been occupied nearly full time this fall on two reports for the Senate Select Committee on National Water Resources, one on Vegetation Management and Water Yields and the other on Research Needs on Water Problems in Agriculture and Forestry. Other agencies of the Department are also participating in the preparation of the reports. Marvin Hoover (RM) and Sim Jarvi (R-3) came into the W.O. to help with the data gathering and preparing the initial draft of the report.

SEMIANNUAL REPORT

Watershed Management Research Division

CENTRAL STATES FOREST EXPERIMENT STATION

April 1, 1959 - September 30, 1959

GENERAL

This period's activities included completing much old work; initiating some new studies; conducting some show-me trips for visitors; attending several meetings and training sessions; reviewing many manuscripts and publications; and purchasing a Nuclear-Chicago neutron, soil-moisture meter. Ambitious plans for the future call for other analyses of past records and the installation and operation of several new work programs.

Cooperation from other agencies in our area is most encouraging. Much help has been received in locating suitable experimental areas and many records have been opened to us for analysis and interpretation. For instance, many excellent experimental areas have been located in the Muskingum Watershed Conservancy District. These areas include small watersheds, pilot watersheds, and plot sites. Many aerial photos, maps, rainfall and streamflow records have been loaned to us. The friendliness and enthusiasm of the District personnel in furnishing facilities, information and records have been most inspiring.

Outstanding also has been the development of close working relations with Region 7, the Wayne-Hoosier National Forest, Region 9, and the Cumberland National Forest on problems associated with strip mining.

The cooperation from all these folks has already produced much valuable information. The opportunity for mutually solving many vexing problems gives us a challenging future indeed.

TWENTY YEARS OF STREAMFLOW RECORDS AT LEESVILLE RESERVOIR SHOW BENEFIT OF LAND MANAGEMENT IN OHIO'S MUSKINGUM WATERSHED CONSERVANCY DISTRICT

by Ronald Z. Whipkey

Leesville Flood Control Dam was built some 20 years ago as a part of the program of Ohio's Muskingum Watershed Conservancy District. A 30,000-acre, hilly, agricultural and forested watershed drains into the reservoir created behind that dam. Other parts of the overall conservancy program for this watershed included improved farming methods for the agricultural land and planting pine tree seedlings on steep, eroded land once cleared for agriculture. Because of these watershed improvements the tenders of some of the flood control dams and some of the Muskingum Watershed Conservancy District personnel have felt that, for rainfalls of the same magnitude, increases in reservoir levels are not as great now as they were initially. This feeling prompted an examination of streamflow and precipitation records at Leesville Dam for the period 1938 to 1958. And, this analysis shows that the improvement in the management of the watershed's farms and woodlands has helped reduce stormflow volumes, especially near the end of the 20-year period.

Using only those rainfalls of 1 inch or more in 24 hours, rainfall depth was related to the resulting stream rise to get the average stormflow for a given amount of rainfall. Comparing differences year by year and season by season showed whether the individual and average rises had been reduced, increased or unaffected.

Over the period, winter flows declined most; fall and summer flows decreased lesser amounts; average annual flows trended slightly downward; but spring flows increased (fig. 1).

Flows were reduced most for rainfalls of 1 to 2 inches and less for storms of 2 to 3 inches. No meaningful change was found in any season for storms above 3 inches.

The upward trend for the April through June season may have been due to extremely heavy rains in June 1947 and April 1948 and an unusual ice storm in April 1957. Large flows from these storms could have been largely responsible for the upward slope of the trend line for the entire spring season. Rainfall in these spring months is erratic, ranging from winter type frontal-storms of long duration and low-intensities to summer type thunderstorms of short duration but high intensity. Usually soil moisture remains high in this period even though some water may be lost through evapotranspiration. This means the soil-moisture storage opportunity is so low that most of the precipitation runs off, either over or through the soil.

Summer rainfall comes as high-intensity, short-duration storms, but soil moisture is usually much less than in the spring. So more of the rain can be stored in the soil and less goes to streamflow.

Ordinarily heavy, flood-producing precipitation does not occur in fall and winter, but large flows may occur in winter even from well-managed areas, if large quantities of rain fall on solidly frozen ground.

Soil type, geology, climate, topography, land use, and vegetative cover control the streamflow from a watershed. Throughout the 20 year period the last two of these have changed steadily on the Leesville Watershed. Although half the watershed is still being farmed and logged as it was 20 years ago, the general trend on the watershed is toward better land use. It is reasonable to assume that this trend will continue until most of the watershed is under a soil conserving program. From the results of this analysis it is also reasonable to assume that as improved land management continues stormflows will decrease, at least for the smaller storms.

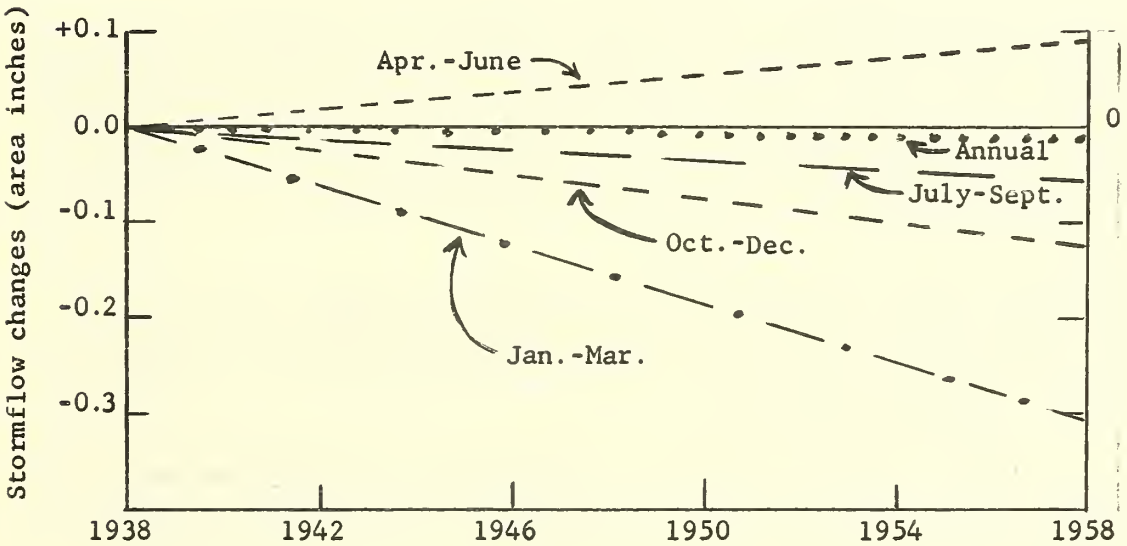

Figure 1.--Changes in average stormflows at Leesville Reservoir for storms 1 inch and greater, 1938-1958.

SUBSOIL WATER MANAGEMENT STUDY

by Ronald Z. Whipkey

Preliminary field attempts to develop equipment for measuring subsoil water movement in forest soils made headway and encountered obstacles.

Our water applicator, consisting of a high pressure fire pump, a pressure distribution manifold assembled from standard pieces of pipe, and six "swirling", lawn sprinkler heads, performed satisfactorily. An average intensity of 5 inches per hour, applied for one-half hour, gave subsurface stormflow from a 10 foot by 20 foot soil block for approximately two hours.

The plot, containing Muskingum silt-loam (stony phase) had an open-pit face approximately 3 feet deep. Trenching along the sides and upper end of the plot isolated a block of soil more than two feet thick. A layer of 4 mm vinyl plastic placed against the sides and top end of this block of soil before backfilling the trenches formed a barrier to the lateral movement of water into or out of the block.

For the first run four metal troughs were cut into the face of the pit at various depths to intercept water moving through different layers of the block. This arrangement was quite unsatisfactory, however. Runoff through the A and B horizons caused erosion and sloughing of the face. The troughs were difficult to install, particularly where rocks interfered. In addition, cutting a slot for the lip of the trough damaged the natural structure of the face.

Some runoff escaped along the plastic soil interface of the side walls. Most of this can be eliminated on future runs, but much yet remains to be learned of the effect of the open soil face and plastic-soil boundary condition upon transverse movement of water or outflow into the atmosphere.

Further work this fall will be aimed at refining equipment and techniques. Items to be investigated are optimum plot width, the need for trenching and isolating the soil block, and a type of porous media that will transmit water into a collection system buried in the ground. Other methods to be used in measuring soil moisture movement are Nuclear-Chicago soil moisture meter and batteries of piezometers. Radioactive and chemical tracers will be considered for use in measuring transmission rates of subsoil water.

HOW PRECIPITATION AFFECTS WATER LEVELS IN STRIP-MINE PONDS IN SOUTHEAST OHIO

by Lawrence W. Hill

Many ponds smaller than five acres in size have been established recently in reclaimed, strip-mine areas near Ironton, Ohio. Little hydrologic information is available from such areas so a recording rain gage and a water-level recorder were installed on a 3-year old, strip-mined, bare-slope, 16-acre watershed containing a 5-acre pond. The pond had no outlet and no feeder streams. All impounded water came from spoil-bank runoff and from rain falling directly on the pond surface.

Knowing watershed size, pond size, pond depth increase, and rainfall depth made it possible to calculate the volume and proportion of runoff from the spoil banks. For example, if a 1-inch rain over the 16-acre watershed produced a 2-inch increase in depth in the 5-acre pond, 5-acre-inches must have run off the 11 acres of spoil bank.

Correlating calculated runoff with rainfall depth from six summer thunderstorms that ranged from 0.24 to 2.00 inches of precipitation gave a linear regression equation of $RO = 0.603\ P - 0.1$ where RO = runoff depth and P = precipitation depth.

Assuming this spoil-bank, runoff relation holds for other rainfall depths and for other watersheds with different spoil-bank --pond ratios makes it possible to predict rises in pond levels, Table 1.

Pond-level increases become larger as the spoil-bank--pond ratios become larger. Also, the larger storms cause much greater increases in pond levels. Hence, if a pond has no outlet and if its proposed use requires that its water level must remain fairly constant, a larger bank--pond ratio is better than a small one. Maximum pond levels can be attained by designing outlets on the basis of the spoil-bank, runoff relation and the values given in Table 1.

Results from this study, though of a preliminary nature, show that approximately one-half the rainfall will run off the surface of bare spoil banks. Ponds in reclaimed, stripped areas can trap this water and delay or prevent it from becoming streamflow. Where no ponds exist the larger proportion of runoff that

comes from spoil banks has a tremendous influence on the time-discharge and water quality characteristics of the streamflow. Additional research is needed to better define the precipitation-runoff relations of bare spoil banks and also of spoil banks that have been revegetated through plantings or natural invasion. Plans are underway to intensify investigation of spoil-bank hydrology in the Central States.

Table 1.--Pond level rise in inches for various rainfall depths and various spoil-bank--pond ratios[1/]

Ratio	Precipitation in Inches			
	1.0	2.0	3.0	4.0[2/]
1:1	1.5	3.1	4.7	6.3
2:1	2.0	4.2	6.4	8.6
3:1	2.5	5.3	8.1	10.9
4:1	3.0	6.4	9.8	13.2
5:1	3.5	7.5	11.5	15.5
6:1	4.0	8.6	13.2	17.8
7:1	4.5	9.7	14.9	20.1
8:1	5.0	10.8	16.6	22.4
9:1	5.5	11.9	18.3	24.7

1/ Based on a pond side slope ratio of 1:1.

2/ A rainfall of 4 inches in 24 hours will occur, on the average, once in 25 years.

EFFECT OF STRIP MINING UPON SEDIMENT SUSPENDED IN STREAMS NEAR CUMBERLAND FALLS, KENTUCKY

by Edward A. Johnson

The tremendous churning of the earth's surface by a strip mine operation is obvious to even a casual observer. Until recently, however, few quantitative measurements have been available to show the effect such churning has on streamflow quantity and quality. Now a cooperative study near Cumberland Falls, Kentucky is beginning to produce some records of the effect of strip mining on the suspended sediment load of affected streams. For instance, U.S. Geological Survey records for Oct. 1957 through Sept. 1958 show that the suspended sediment carried by the stream from strip-mined Cane Branch watershed totalled 75 times as much per unit of area as that from undisturbed Helton Branch watershed nearby.

Cane Branch, with a drainage area of 0.67 sq. miles produced 823 acre feet of water and 1295 tons of suspended sediment. These convert to 1228 acre feet of runoff per square mile per year, 1930 tons of suspended sediment per square mile per year, and 1.57 tons of suspended per acre foot of runoff. Maximum daily load of suspended sediment was 520 tons on April 24, while the minimum daily load of less than 0.005 ton occurred on several days. In contrast Helton Branch, with a drainage area of 0.85 sq. miles, produced 1058 acre feet of runoff, but only 22.8 tons of suspended sediment. These convert to 1245 acre feet of runoff per square mile per year but only 25.8 tons of suspended sediment per square mile per year and 0.022 tons of suspended sediment per acre foot of runoff. Maximum daily load of suspended sediment of 7 tons came on Nov. 18 and the minimum of 0.0005 occurred on several days.

Plotting the accumulated monthly totals of suspended sediment reveals that Cane Branch produced huge quantities in Nov. and April and relatively minor quantities in all other months. In comparison, Helton's production totalled only 1/75th as much as Cane's, but Helton's largest relative amounts also came in November and April (fig. 2a).

A bar diagram of the monthly tonnage of suspended sediment per acre foot of runoff shows that Cane Branch produced high concentrations in July and September as well as in November and April (fig. 2b). Only relatively dilute concentrations ever came from Helton Branch. Here November ranked highest, April second (43% as much as Nov.), December third, February fourth, and May fifth (13% as much as Nov.).

Combining the results displayed in figures 2a and 2b reveals that Cane Branch had large volumes of runoff and high concentrations of suspended sediment in November and April. This gave large volumes of sediment and must have been due to large quantities of precipitation from winter-type, cyclonic, low intensity storms. The small July and September flows with high suspended sediment concentrations yielded only small volumes of sediment and must have been due to high-intensity thunderstorms.

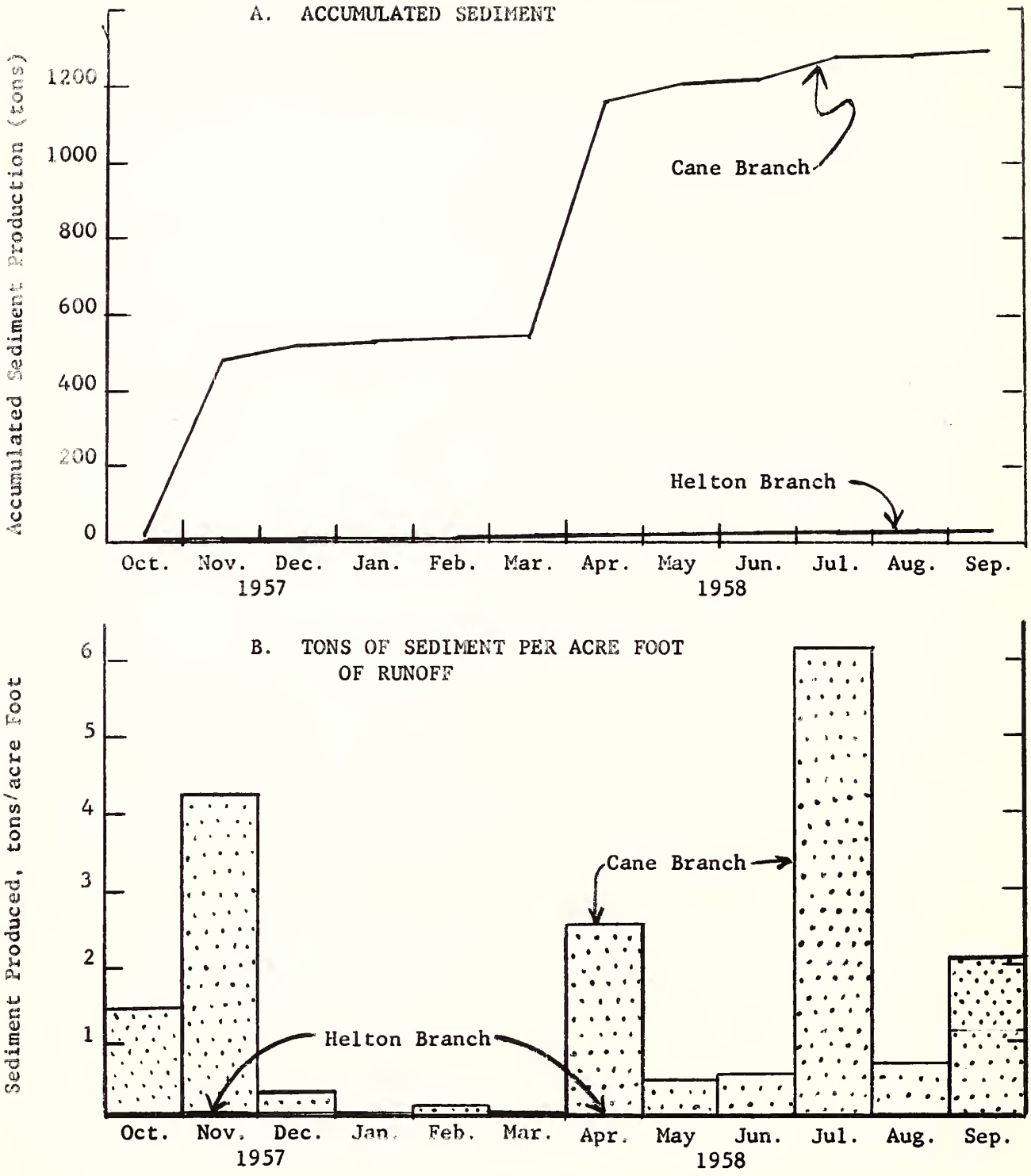

Figure 2.--Effect of strip mining upon sediment production from two streams near Cumberland Falls, Kentucky, Oct. 1957-Sep. 1958.

INFLUENCE OF FIVE FOREST LAND COVER CONDITIONS ON SOIL MOISTURE

By Richard B. Marston

Soil moisture content under five kinds of forest land cover conditions was studied over the 22 month period, March 1956 to January 1958, by the use of gravimetric samples from plots on the unglaciated, shallow soils of southeastern Ohio. The results show that pine used more water than oak; oak used more than brush; brush used more than grass; and grass used more than was evaporated from the vegetationless, clearcut plots.

The average of gravimetric samples, taken from the whole 0-36 inch profile on several dates near the end of the dormant season and used here as a measure of field capacity varied from 11.49 inches of water under pine to 13.12 inches under grass.

Generally, soil moisture declined from field capacity throughout the summer and was recharged to it during the winter, but occasionally large, summer rainstorms caused full recharge.

Total water used in a 6-month growing season ranged from 22 inches under grass to 25 inches under pine. Additional water was used by pine during the dormant season and the two-year average amount of precipitation required to recharge the soil was 6-1/2 inches greater under pine than under grass. Grass is the minimum cover condition practical here, as in many places elsewhere. Manipulation of vegetation to increase water yields must not reduce total ground cover below that necessary to maintain stable soil. The inclusion of the vegationless, clearcut type in this study was opportunistic. Because of the previous good cover and the short time in which all vegetation was kept killed out, little bare soil was ever exposed on these plots and no obvious gullying or erosion occurred. These plots are useful here as a base for comparison, but a vegetationless condition is of academic interest only. Treatments must be avoided if they bare the soil either immediately or eventually. The horrendous erosion that occurs from bare soil cannot be tolerated even though total streamflow is increased.

Even on these thin soils the 2-year average, 6-1/2 inch difference between a good forest cover and grass (in amount of precipitation required to recharge the soil) shows that a good opportunity exists in this area to affect streamflow and flood control through manipulation of the forest cover.

Calculations by two methods showed water use by the different cover types on an actual, horizon depth basis and on a 1-inch layer basis. The results from both methods are useful in explaining the differences between cover conditions. The 1-inch layer basis showed that all cover types used relatively large quantities of water out of the A horizon, that the clearcut evaporated much less from the B and C horizons; that grass used a large amount per inch of A, a fairly large amount per inch of B, but only a small amount per inch of C; and that brush, pine and oak used large quantities from all three horizons.

Calculations on the actual profile basis, on the other hand, show that the bulk of the water used came from the lower horizons because these horizons are thicker and contain a greater total amount of water.

Though the results from this study may apply in a general way to similar areas elsewhere, extension to such areas even though the soil type may be the same, should be on an actual profile basis. This may be done by dividing the amount for a 1-inch layer by the bulk density of the appropriate horizon (Table 2) and then multiplying by the bulk density and depth of the horizon to which it is to be extended.

The results from this study exemplify the two opposing objectives that may be proposed for a watershed management program. One is the possibility of increasing streamflow by decreasing transpiration through the manipulation of the vegetative cover. The other is the possibility of decreasing floods by providing in the soil the maximum amount of storage space for precipitation through the maintenance of heavy growths of vegetation. Thus, in this study, increased streamflow would be expected through conversion from pine to oak, to brush, to grass, to clearcut and increased flood control benefits would be expected by proceeding in the opposite direction, (fig. 3).

Table 2.--Soil moisture deficit in inches for different volumes of soil, five forested land cover conditions, southeastern Ohio.

Cover type	Horizon	Bulk density	Moisture deficit 7/16/56		Moisture deficit 1957 (Ave. of 8/26 and 9/9)		Average of 1956 and 1957	
			Actual profile	Per one-inch layer	Actual profile	Per one-inch layer	Actual profile	Per one-inch layer
Clearcut	A	1.438	.33	.06	.82	.16	.58	.11
	B	1.615	.20	.03[1]	.82	.11	.51	.07
	C	1.624	1.09	.05	1.43	.06	1.26	.06
Grass	A	1.223	.99	.16	1.39	.22	1.19	.19
	B	1.488	.86	.08	1.71	.16	1.28	.12
	C	1.601	.89	.05	1.56	.08	1.23	.06
Brush	A	1.424	.83	.15	1.21	.22	1.02	.18
	B	1.652	.74	.10	1.41	.19	1.08	.14
	C	1.658	1.59	.07	2.72	.12	2.15	.10
Pine	A	1.364	.84	.15	1.30	.24	1.07	.20
	B	1.573	1.06	.15[2]	1.54	.22	1.30	.18
	C	1.605	2.20	.09	2.87	.12	2.53	.10
Oak	A	1.273	.61	.20	.73	.23	.67	.22
	B	1.424	1.70	.17	1.79	.18	1.74	.18
	C	1.481	2.53	.11	3.36	.15	2.95	.13

1/ Horizon B less than C.

2/ Horizon B equal to horizon A.

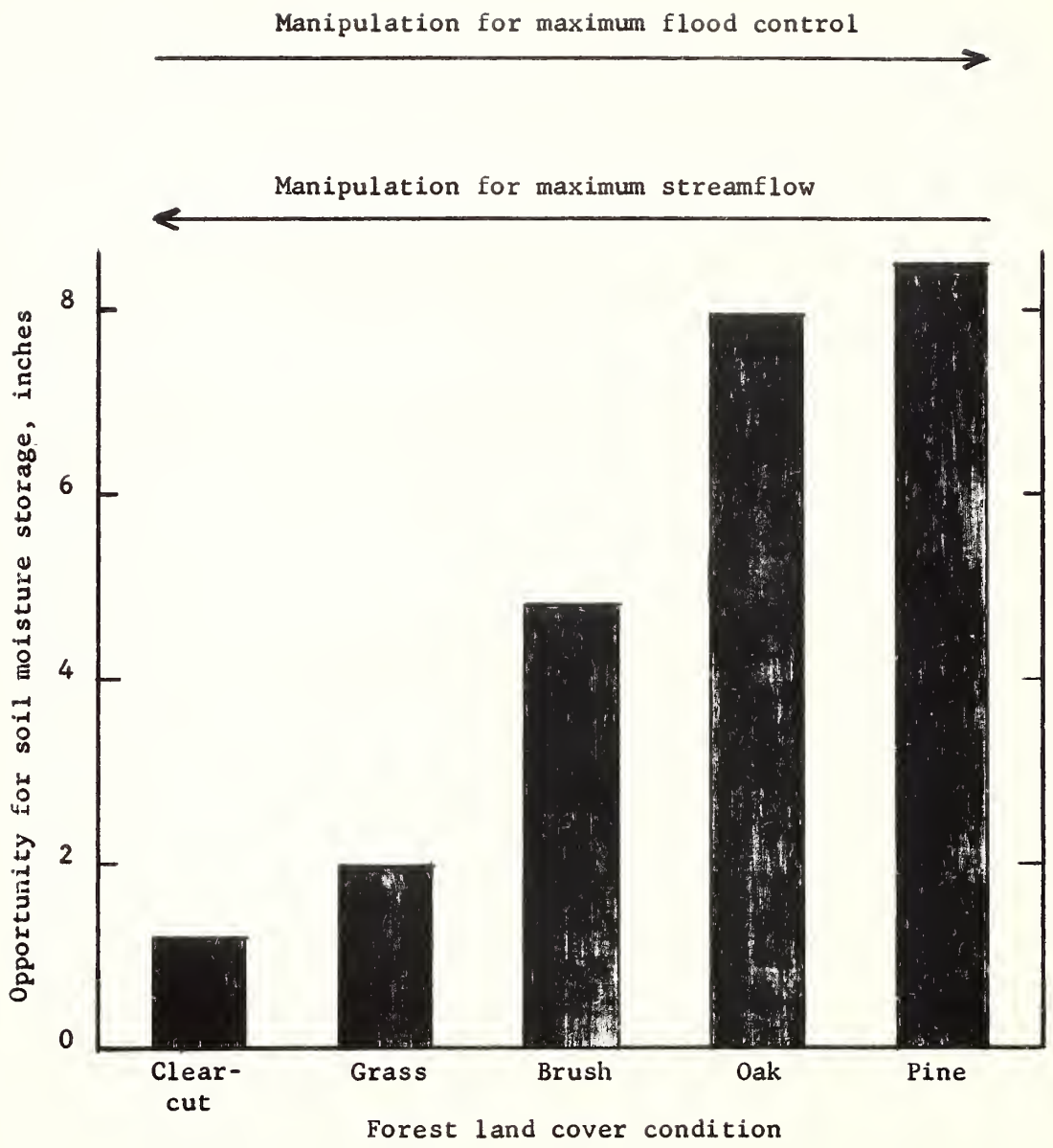

Figure 3.--Influence of forest land cover type upon soil moisture storage opportunity.

VISITORS

4/3-4 Richard Sartz, LaCrosse, Wisconsin - Columbus, Coshocton, New Philadelphia.

5/8 Professor Robert Zahner and 12 students from University of Michigan, Ann Arbor, Mich., - Coshocton.

5/20-22 Yungjoon Kim, Chief ROK Bureau of Forestry; Kyungwhan Lee, Chief Soil Conservation Subsection; Yooil Choi, Chief Kangnung National Forest Station; and Taieung Cho, Chief Director Central Forestry Association, Seoul, Korea. - New Philadelphia.

5/26 Francis Baker, Columbus, Ohio. - Inspected soils on Dover watersheds.

6/10-11 Monico N. Nastor, Quezon City, Philippine Islands. - Columbus, Coshocton, and New Philadelphia.

6/17-18 Pit Hambanonda, Thailand. - Columbus, Coshocton, New Phila.

6/25-26 Ted Osborne and Chet Jensen - Columbus and Athens.

7/14-16 Abraham Owusu Afriyie, Ghana, West Africa. - Columbus, Circleville, Chillicothe, Jackson, Athens.

8/20 Warren T. Murphy and FAO sponsored group of 32 foreign watershed technicians. - New Philadelphia.

MEETINGS

4/9 P.L. 566 Program for Marsh Run Watershed, Columbus, Ohio. - Marston.

4/15-16 Discussion of hydrology of strip mine ponds with Wayne National Forest and Region 9 personnel, Ironton, Ohio. - Johnson, Marston, Whipkey, Hill.

4/19-22 Field inspection of demonstration drainages in a joint timber and watershed management project. Purpose of project is to determine methods of establishing and measuring forest stands that promote soil stability. Ames Research Center, Cedar Rapids, Iowa. - Johnson.

5/11 Program Conference for proposed research on forested watersheds at Agr. Research Service Station, Coshocton, Ohio. - Johnson, Marston, Roach, Whipkey, Hill.

MEETINGS (contd.)

5/15 Conference with Dr. Glen Schwab on Soil Physics, Drainage, and Subsoil Water Movement, Columbus, Ohio. - Marston, Whipkey.

5/18-22 Field conference with Watershed Management and State and Private Forestry representatives from Washington Office and Region 9 on forestry practices for P.L. 566 watersheds in Region 9. - Johnson.

5/25-28 Work group committee meeting for Beaver Creek strip mine project near Cumberland Falls, Kentucky. - Johnson, Williamson.

7/6-10 Writer's training detail, Athens, Ohio. - Whipkey, Hill.

7/28-30 Work Group Committee Meeting for Beaver Creek strip mine project, Louisville, Kentucky. - Johnson.

8/4 Discussion of hydrology of strip mine ponds with Wayne National Forest, Region 9, and Missouri School of Mines personnel, Ironton, Ohio. - Johnson, Marston.

8/14 S.C.S.A. field day at North Central Ohio experimental farm near Castalia, Ohio. Conferred with Dr. Schwab on drainage experiment. - Marston, Whipkey.

8/24-28 S.C.S.A. National Meeting, Rapid City, South Dakota. - Johnson.

9/8-10/2 Statistical training seminar, Ames, Iowa. - Whipkey, Hill.

9/9-10 Representatives from Lake States, Central States, and State and Private Forestry of Region 9, preparing plans for working with Senate Select Committee on National Water Resources, Milwaukee, Wisconsin. - Johnson.

LECTURES

June 15 - Rotary Club, Dover, Ohio. "Forest Watershed Management Research in Ohio." - R. Z. Whipkey.

Sept. 6 - Youth Group, Methodist Church, Acme, Penna. "Careers in Forestry." - R. Z. Whipkey.

MANUSCRIPTS

Hill, Lawrence W. - Precipitation and runoff relationships on a reforested watershed in southeastern Ohio. Master of Forestry Thesis accepted by University of Michigan.

Marston, Richard B. - Influence of five forest land cover conditions on soil moisture. Submitted to the editor.

_____ - Disposition of precipitation on some aspen and mountain brush sites in northern Utah. Ph.D. Thesis submitted to committee chairman.

Whipkey, Ronald Z. - Twenty years' streamflow records show effect of improved land management. Submitted to the editor.

_____ - Precipitation and runoff from some small Ozark watersheds. Being prepared for final editing.

REVIEWS

Todd, David K., 1959. Ground Water Hydrology. John Wiley and Sons Inc., New York, 336 pp., Illus. Refer. $10.75.

Review by E. A. Johnson submitted to Journal of Soil and Water Conservation.

Broadfoot, Walter M. and Hubert D. Burke, 1958. Soil Moisture Constants and Their Variation. Southern Forest Expt. Sta., For. Ser., U.S. Dept. Agr. Occasional Paper 166, 27 pp., charts, tables, biblio.

Review by R. B. Marston submitted to Journal of Soil and Water Conservation.

SEMIANNUAL REPORT ON WATERSHED MANAGEMENT RESEARCH
Intermountain Forest and Range Experiment Station

April - September, 1959

GENERAL

This Station was host to numerous visitors this past summer from many parts of the United States and several foreign countries. The FAO Watershed Management Seminar and Study tour spent a part of one day at the Great Basin Research Center. Director Bailey discussed with the group some of the watershed management problems and programs in the Intermountain Region.

Copeland and Haupt attended the Western Snow Conference in Reno, Nevada on April 21-23. Copeland participated in a portion of the Second Annual Technical Work-Planning Conference for Forest Service soil scientists held in Ogden and Region 4 during the period August 24 through September 4.

Attention was again focused this summer on the vital role of plant cover in flood control in this region. One widely publicized flood is worthy of comment. Early on the morning of August 20, a high-intensity summer rainstorm centered over the foothills northeast of Boise, Idaho. In a short time, nine dry or low flow channels were transformed into surging mud-rock flows. Flood discharges of four drainages converged into one channel leading into Boise. Damage amounting to more than one-half million dollars was sustained by property over a 50-square block area. Rural property, livestock, crop, and equipment losses were caused by the flooding of five drainages to the east of Boise.

The flood-source areas customarily support a cover of cheatgrass and scattered sagebrush. A fire on August 3 denuded completely more than 9,000 acres. Earlier during the summer, a smaller fire burned over a few hundred acres. In the two preceding summers, fires burned another 3,000 acres, and plant cover development following those fires was very poor. Thus, altogether, more than 12,000 acres of bare or sparsely covered land contributed overland flow.

Channels were ripped to depths of 6 feet at distances of 300 yards below the crest of the watersheds. Rill erosion was exceedingly severe. The entire landscape appeared as if it had been swept clean with a broom and then raked with a giant rake.

The Division of Watershed Management Research, the Boise Research Center, and the Boise National Forest pooled their efforts to conduct a flood survey and prepare a report. A restoration and flood control program is now being considered by the local agencies.

Publications

Haupt, Harold F. 1959. Road and slope characteristics affecting sediment movement from logging roads. Jour. Forestry, 57:329-332.

Haupt, Harold F. 1959. A method for controlling sediment from logging roads. Intermountain Forest & Range Expt. Sta. Misc. Pub. No. 22, 22 pp., illus.

Packer, Paul E. 1959. Watershed management problems in the Northern Rocky Mountain Region. Intermountain Forest & Range Expt. Sta. Res. Paper No. 57, 28 pp., illus.

Manuscripts accepted for publication

Kidd, W. J., Jr. The use of ethylene glycol in seasonal storage precipitation gages. Jour. of Forestry.

Meeuwig, Richard O. Watersheds A and B - A study of surface runoff and erosion in the subalpine zone of central Utah. Jour. of Forestry.

Haupt, Harold F. Variation in areal disturbance produced by harvesting methods in ponderosa pine. Jour. of Forestry.

BOISE RESEARCH CENTER

Modified logging methods (FS-1-w5-2)

Instrument installations on the Zena Creek logging study area on the Payette National Forest were commenced this past spring. Three recording rain gages and three standard rain cans were placed on separate ridges several miles apart as a start in gathering precipitation data for the area. Rainfall catch throughout the field season (April - October) was remarkably uniform for all gages. In September, a standpipe type storage precipitation gage was erected on Tailholt ridge to catch and accumulate winter precipitation because the area is inaccessible during winter months.

Stream channel cross sections were staked and surveyed in the four major streams of the planned sale area. These will be remeasured annually to determine the amount of streambank erosion before and after logging. A small log dam was constructed across one of the streams to serve as a bedload sediment trap. The pond area was gridded and surveyed so that future resurveys can be used to calculate the amount of sediment moving downstream.

The installation of a weir and water level recorder house on Tailholt Creek, one of the four major streams of Zena Creek sale area, was completed by Region 4.

Soil moisture storage (FS-1-w1-6)

A soil moisture depletion study was started on the Little Beaver Creek sale area, Boise National Forest, this summer. The logged area has closely spaced logging roads on moderately steep slopes, and was practically clear cut. The object of this study is to determine, by moisture sampling along a transect from the top edge of cut banks to the toe of the fill slope above them, whether an intensive road net lowers the water table or leads to excessive site dessication, and if so, how far the influence extends up slope from the roadbank cuts. Three transects were run on the logged area; one transect on an unlogged area. This study will be repeated next spring. Results of this past season's sampling were inconclusive because of a late start in sampling.

W. J. Kidd

GREAT BASIN RESEARCH CENTER

Modified grazing practices (FS-1-w5-4)

How should the high mountain ranges of Utah be grazed? That is, how much and when should they be grazed to get the most grazing use with minimum damage to watershed stability? We know part of the answer to this question. We know that generally about two-thirds of the soil surface must be protected by vegetation or litter during the summer storm season to keep overland flow within safe limits and prevent soil erosion. And we know that livestock can increase the erosion and flood potentials by reducing ground cover and by trampling, but we have little quantitative information about the effects of grazing on soil stability and infiltration capacity and how these effects may vary with soil and vegetal characteristics.

An infiltrometer study was made this summer on a cattle allotment in Manti Canyon to provide some information on the effects of grazing. Plots were established on areas supporting native vegetation and on areas that had been seeded to grass seven years ago. Half of the plots on each area were grazed the past four years but not this year; the other half were covered by wire cages and had not been grazed since 1952.

Results of this study have not been analyzed completely, but so far we have found infiltration to be significantly higher and soil erodibility significantly lower on the protected plots. There were no significant differences in infiltration or erodibility between seeded or native plots which had been grazed. A report of this study will be issued when the analysis is completed.

Richard O. Meeuwig

MISSOULA RESEARCH CENTER

Substantial progress was made on a number of studies this past summer, but it was chiefly of the nature of field work or continuing analytical operations.

The snow accumulation and snow melting data (FS-1-w1-2) were examined more intensively and additional analyses planned. The range restoration study (FS-1-w6-1) in relation to soil movement as caused by game animal trampling will require additional time for more conclusive results.

In connection with the logging road erosion study (FS-1-w5-3), field work was completed on another soil group; soil analyses were completed on all samples collected last year, and are now being made on the samples collected this year.

P. E. Packer

RENO RESEARCH CENTER

Calibration of Dog Creek watersheds (FS-1-w3-2)

This past season weir sites were selected and construction work started on watersheds 1 and 2 which sample old-growth, cutover, and burned pine-fir areas in the steep upper reaches of the Truckee basin. The control adopted for the Dog Creek watersheds was a combination broad crest and 120° V-notch weir design, believed most satisfactory for the flows expected. Except for installing the A-35 recorders, the gaging stations were ready for operation by September 15--had there been runoff to fill the stilling ponds. Surface flow here, as well as in other minor drainages along the eastside of the Sierra, ceased early in the summer as a result of prolonged drought. The last general storm to produce more than .02 inches rain occurred May 19-21. Prior to this storm, winter and spring precipitation had been 45 percent of normal. Although we lament the dry year, our construction crew was delighted with the low streamflow at the weir sites.

We would like to open for and solicit comment on the subject of sediment traps and their effect on timing and magnitude of peak flow measurement. Plans call for construction traps above the stilling ponds. Little debris is expected from watershed 1, unlogged and in good cover condition. During calibration, considerable debris is expected from watershed 2, which has been partially denuded by fire. Alden Hibbert, at Coweeta, proposes an alternate procedure of constructing traps below the gaging section. However, they have experienced some difficulty on their watershed 3 with alteration of hydraulic characteristics by rocks and other material in front of and below the gaging section. What are your ideas on this subject?

Truckee watershed condition inventory (FS-1-w4-2)

Our problem analysis pointed up the need for more factual information on the status of the land and hydrologic resources within the upper Truckee River basin. Preliminary plans have been drafted to inventory certain forest and hydrologic characteristics within this critical watershed.

Results from this extensive inventory will be used to help in the design of plot studies by making certain that these studies recognize priority problem zones occurring in the Truckee. We hope this study will also serve as a springboard for a very intensive investigation of topography, plant cover, and soil conditions in the Dog Creek watersheds.

Harold F. Haupt

WASATCH RESEARCH CENTER

Gross precipitation (FS-1-w1-1)

Precipitation at the Farmington station of the Davis County experimental watershed during the water year ending October 1, 1959, amounted to 19.20 inches or 92 percent of normal. This percentage was approximately the same or slightly higher at climatic stations located at higher elevations on the watershed proper. Precipitation for the months of October, November, December, March, April, and July was below normal and ranged from 0 percent to 82 percent of average. Precipitation in 4 of the remaining 6 months was slightly above average. August precipitation was 164 percent of average and during September a record amount of rain fell into the official bucket--2.58 inches of rain at the Farmington station was 344 percent of the 20-year average.

Parrish runoff and erosion plots (FS-1-w6-1)

From the middle of June through September, 27 summer storms produced 8.74 inches of precipitation in the head of Parrish Canyon. Two-thirds of these storms accounted for 89 percent of the total summer precipitation and caused overland flow and erosion from the three denuded plots. Small amounts of overland flow from some of the vegetated plots failed to erode any measurable amounts of soil.

Nineteen storms caused overland flow from plot 7 that totaled 309 cu. ft. and wet sediment eroded amounted to 45 cu.ft. or 450 cu.ft. per acre. Similar results were obtained on the two smaller denuded plots. Maximum 5-minute storm intensity recorded was 2.40 in./hr.; minimum intensity recorded was 0.12 in./hr.

Chemical analyses of six randomly selected samples of soil from an aspen-covered area immediately adjacent to plot 7 show that after 25 years of protection from fire and grazing, the soil organic matter content of the 0-1" layer has increased 4.3 percent and for the 1-6" layer, 3.2 percent.

Evaluation of upstream flood control methods (FS-1-w6-4)

Analyses of records for several years are now under way to determine the manner in which upstream restoration treatments may have influenced streamflow. Several interesting bits of information have been revealed thus far. Summer streamflow from Halfway Creek, that drains a watershed whose cover was badly depleted but now partially restored, is made up of 98 to 99 percent seepage flow and only 2 percent or less of channel interception and overland flow.

The percentages of annual streamflow by quarters from 5 streams in exceedingly wet and dry years are interesting.

	Quarterly percentages of annual streamflow			
	Dec.	Mar.	June	Sept.
1951-52 (wet year)	7	15	88	100
1953-54 (dry year)	23	47	85	100

July-September is the period when water supplies are critical. It is interesting that irrespective of the volume of precipitation, 12 to 15 percent of the annual streamflow is yielded during this period. Volumewise, the yields differ appreciably, but percentagewise they are quite constant.

Time trend analyses of streamflow from Parrish Canyon by various periods show that the restoration of plant cover on denuded headwater areas after a period of 22 years has caused a statistically significant reduction in water yield. However, the actual difference is so small (0.015 inches per year) that it is of little practical significance.

Dale J. Pfankuch

LAKE STATES FOREST EXPERIMENT STATION

General

One of the important features of this 6-month period was the movement of personnel. In July Station headquarters lost the services of Joe Stoeckeler for a year who accepted a postdoctoral fellowship. The East Lansing Center temporarily lost Dave Striffler who returned to Ann Arbor, Mich., for a year's study toward his Ph.D. He is doing his work under a former Forest Service man, Robert Zahner. To help counterbalance the loss in manpower, the Grand Rapids Center now has Don Boelter, Soil Physicist from Minnesota University. Incidentally, he too worked under a former Forest Service man, Bill Martin, who is now head of the Soil Science Department.

A major emphasis at all Centers was the preparation of Problem Analyses. Two of the three Centers--East Lansing and Grand Rapids--have completed and approved analyses.

The selection of research areas is virtually complete. Instrumenting for long-range studies is under way.

As suggested, here is a list showing location of our permanent personnel:

Station headquarters, St. Paul, Minn.	Weitzman Stoeckeler (educ. leave
East Lansing Research Center, Cadillac, Mich.	Urie Striffler (educ. leave)
Grand Rapids Research Center, Minn.	Bay Boelter
La Crosse Research Center, Wis.	Sartz Curtis

East Lansing Research Center

Experimental Areas

The search for a representative experimental area has culminated in the final selection of two potential research areas. These two areas were selected from a total of some twenty-one possibles and represent the general hydrologic situation in Michigan's northern Lower Peninsula.

The hydrology of these areas is unique. The old axiom that water runs down hill does not hold true. Rain falling on the ground is merely slowed up a little until it reaches the water table. Water flowing from the upland moraines to the outwash plains is almost entirely subsurface. Streams are rarely found in the morainal watersheds.

Udell Hills Area

The first area we have selected is the Udell Hills area. The Udell Hills consist of an isolated ring of hills forming the western end of the main Port Huron Moraine. Probing with an auger has enabled us to determine ground-water gradients sloping away from the moraine in all directions. An elevated water table also occurs in the center of the ring. A group of small watersheds has been delineated on the northwestern ridge of the moraine. Two of these face out to the north and west, the other three face in toward the east and southeast. No surface waters occur in any of these units which range from 40 to 110 acres. Further investigation has suggested that the surface topography reflects the topography of a subsurface till material which, in effect, forms a slowly permeable floor or bottom for several of these watersheds. (Installation of our first test wells supports this theory.) This being true, it is reasonable to assume that water movement down these watersheds concentrates in the bottomland. By the judicious location of wells, we may be able to determine rates and eventually volumes of subsurface flow. A rain gage network and system of wells are currently being installed.

Briar Hill Area

Our second area, Briar Hill, is a much more complicated morainal formation. Investigation in this area has not been as intensive as in the Udell Hills; however, a series of watersheds have been delineated of which three support permanent surface flows. These watersheds are larger, have finer textured soils, more mesic cover types (northern hardwoods and aspen), and cover a greater range of elevations. No immediate work is planned in these areas.

Line Project No. FS-1-wl-6-LS
Soil Moisture Depletion by Cover Types

A study of soil moisture depletion under the important forest cover types of northwestern Lower Michigan was completed in October. Gravimetric sampling methods employed were found satisfactory for the uniform sand or clay soil but inadequate on morainal areas where radical textural changes occurred over short distances in area and in depth. The 1958 growing season followed a year of near drought condition. The soil moisture levels were at or near field capacity in all plots in early April but soil moisture levels were near the wilting point in all sand soils regardless of cover types by late July. Rainfall was below normal until June. Moisture reserves under red pine plantations were depleted early in the season while oak and northern hardwood stands utilized the stored soil moisture during late June and early July. By late July, all forested soils were at about the same level of depletion.

The importance of evaporation losses in coarse sand soils was illustrated by the depletion of soil moisture under sparse grass cover. Two plots in the cover type were found to be depleted to nearly the same level of nearby forested soils at the end of the summer dry period.

Theoretical evapotranspiration rates were calculated from mean daily temperatures using Thornthwaite's formula. Comparison between the measured soil moisture losses and those computed from the temperature values resulted in a cumulative error for the season of 0.6 inch. Total evapotranspiration for the April to October period was 16.5 inches; therefore, the possibilities of the formula approach to predicting soil moisture levels seem promising.

--Dave Striffler
--Dean Urie

Grand Rapids Research Center

Personnel

The permanent watershed staff at the Center has now been doubled. Don Boelter, who has just finished his Ph.D. course work at Minnesota, joined the staff in July as a soil physicist. Forestry and northern Minnesota were relatively new to Don but he arrived at a time when everyone was "beating the brush" for the selection of experimental areas, so he's already been initiated into the fraternity of mosquito swatters, poison ivy scratchers, and swamp waders!

We also had student Clyde Shumway back for a second summer. Clyde's now back at Minnesota doing graduate work in forest influences.

New Lab Facilities

The construction of a new forest research building is well under way here in Grand Rapids. Besides providing much needed office and library space, it will also contain four large laboratories for work in forest biology, forest management, seed studies, and soils and water relationships. We plan to have a well-equipped soils lab which will include nutrient analysis equipment. Plans call for moving into the new building early next spring.

Soil Moisture

Soil moisture samples were taken to 7 feet during the 1957 and 1958 growing seasons at the Pike Bay Experimental Forest. Samples were taken under several types of vegetation and two quite different soils.

Using the changes in soil moisture and the amount of precipitation between sampling dates, the amount of moisture loss was calculated. Moisture loss includes evaporation, transpiration, and drainage.

The sampling period represents the period of time between the disappearance of frost in the spring and the end of the active growing season. Some of the results are given in the following table:

Inches of water loss under several vegetation and soil types at the Pike Bay Experimental Forest

Vegetation	Stocking level	Soil	Inches water loss 1957 1/	Inches water loss 1958 2/
	Sq. ft. B.A.		0-7 ft. profile	
Aspen	50	Heavy 3/	22.8	17.0
Aspen	65	Heavy	23.4	16.6
Aspen	80	Heavy	23.7	22.6
Aspen	115	Heavy	22.3	18.0
Open (grass)	--	Heavy	20.1	15.4
Balsam fir	135	Heavy	21.9	16.4
White pine	170	Heavy	20.5	15.5
Red pine	95	Heavy	18.5	13.9
Aspen-birch	55	Heavy	24.8	15.6
Jack pine	125	Sandy 4/	21.2	12.9
Aspen	130	Sandy	25.4	13.4

1/ May 1, 1957 - September 5, 1957.
2/ May 22, 1958 - September 10, 1958
3/ 12" - 18" of fine sandy loam to silt loam over a tight blocky clay loam.
4/ Deep loamy fine sands.

Precipitation at Pike Bay during the sampling period was 21.51 inches in 1957 as compared to 10.47 inches in 1958.

There seems to be no relationship between moisture loss and stocking level of aspen. It seems, however, that the aspen areas always lost more moisture than comparable areas of open grass or other tree species. This agrees with results reported by H. E. Brown at Grand Junction in the April-September 1958 Semiannual Report.

We should point out, however, that the first 7 feet of soil under aspen contained 1" to 4" more moisture than other sites at the first sampling date. We find this hard to explain. The physical properties of the soils are similar. Literature indicates that the earliest date of active growth is about the same for the various tree species compared.

Samples taken in November of the previous years indicate that the soil was at or near field capacity. The first sampling of the following growing period found that all soils were at field capacity with the aspen areas slightly above field capacity.

Could higher transpiration rates by conifers in early spring, even though growth has not started, account for their lower soil moisture values in May? Trends in moisture loss during May indicate that the conifers may be using more moisture than the aspen during the early stages of growth.

--Roger R. Bay

La Crosse Research Center

We have been in business here in the unglaciated area for just about a year now. And though our physical accomplishments have been somewhat limited, we do feel that we have got well under way. We have acquired an experimental forest--almost. We have been purchasing supplies and instruments, including a Nuclear Chicago soil moisture meter, and just recently, a Zeiss, self-leveling level.

Incidentally, we recommend the last item highly to anyone who does much precision leveling. It is not only lighter and much more compact than conventional levels, but the self-leveling feature is a real time saver. Cost of level and tripod is about $650.

We have made an extensive soil survey of our experimental forest. We have started on our program of research installations. But, most important, we have learned many things about the land that we are working in.

This is strange country for a forest watershed researcher. Completely forested watersheds are scarce and are unimportant as far as local problems are concerned. Forest land is usually found only as a middle zone, sandwiched between two levels of farming. Yet the forest land is extremely important. It occupies the steepest land, often 100 percent slope or more. Without it this country would have washed down to New Orleans long ago.

Because of the loess soils, soft sandstone bedrock, and high intensity convection storms, the area is notorious for floods and erosion. People will point to the gullies coming out of the woods and say, "You've always had erosion here. It's natural." But it isn't natural. We are convinced of this now. It is probably true that much of the sediment and rock debris that are washed down by floods do come from forested slopes. But the water that starts it moving doesn't. It comes from cultivated uplands that lie above the woods.

Protected woods yield little, if any surface runoff. Past research has indicated this and our own observations so far have borne it out. We do have several completely forested watersheds on our experimental forest. We installed an inexpensive 120° V-notch weir made out of a stock-watering tank on one of them this summer. Since putting it in we have had two flood-producing storms, one of which was a near record in the locale of our forest. Total runoff from our 40-acre wooded watershed from both storms has been about 20 cubic feet. And we suspect that most of this came from a small area just above the weir.

So our problem here is not so much runoff from the forests--though we must still investigate runoff under different forest uses. It is: How can the forests help to control runoff from above? To study this we must measure runoff at both the head and foot of the forest zone. Since headwaters runoff may enter the forest at 12 or more different places on a single watershed, each watershed that we study may require 4 or more gaging stations, and even then we will only be sampling upland runoff.

Although there are many springs, we have no permanent streamflow on our experimental forest--even from a 2- to 3-square-mile drainage. Springs flow only a short distance and then seep into the ground. Some springs emerge in runoff channels but as many come out of sidehills or ridges. A good question here in regard to ground water seems to be, "Where is a watershed?" We don't know yet, but the study of springflow will be an important part of our research.

You've all heard stories about springs drying up after the trees were cut. The only way that this can happen is if cutting the trees results in increased surface runoff. Here we have this situation. A large part of the precipitation that falls on non-forest land runs off. If we can get this water into the ground we should be able to show substantial increases in springflow. But first we have to crack the "where is the watershed" problem.

Miscellaneous

Since we have run on at some length in the foregoing we will be extra brief with the rest of our report.

Sartz gave a paper on watershed management research in the Driftless Area at the annual meeting of the Wisconsin Academy of Sciences, Arts, and Letters.

Stoeckeler's and Curtis' paper, "Soil moisture regime in southwestern Wisconsin as affected by aspect and forest type" has been accepted by the Journal of Forestry.

The Wisconsin Conservation Department has obtained options to sell for about two-thirds of our proposed 2,800-acre experimental forest. Most of the other owners are expected to agree to sell.

In our last semiannual we described a combination maximum peak and suspended sediment stage setup. The maximum peak method works well, but we found that the $\frac{1}{4}$-inch copper tubing used with the sediment samplers was not rugged enough for debris-laden flows. The tubing was often bent and twisted. Where it was not, however, good samples were collected.

We have had some experience with our neutron soil moisture meter and so far we are enthusiastic. We are using aluminum access tubes. It is not only more durable and much lighter and easier to handle than steel, but it is also much cheaper. The only difficulty that we have had with the method so far is instrument drift described by Knoerr and others, but this can be compensated for by taking more frequent shield readings.

--Richard S. Sartz

Publications

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NORTHEASTERN FOREST EXPERIMENT STATION

Division of Watershed Management Research

Semi-annual Report October 1959

GENERAL

Some six-month period we may have nothing to report; everyone real busy--but just nothing to say. Not so this period: With noses to the grindstones as we lead visitors around (our grindstones are portable) we ground out the following:

ELKINS RESEARCH CENTER

Treated Watersheds

Sufficient time has elapsed since logging the commercial clearcut watershed to show the seasonal pattern of increase in flow:

Increase in Streamflow After Start of Logging[1/]

		Growing Season (May - Oct.)	Dormant Season (Nov. - Apr.)
		Area Inches	
Water year 1957-8	(5/57-4/58)	1.3	0.9
Water year 1958-9	(5/58-4/59)	4.5	0.6

1/ Logging started May 15, 1957, was completed June 15, 1958.

The growing season increases are significant at the 5 percent level; the dormant season increases are not significant.

Sprouts and herbaceous growth are now very prolific in this watershed. This may explain why already the effect of treatment is apparently decreasing. Records for the first 3 months of this year's growing season have been worked up; increases in streamflow compared with those the year before are as follows:

Increase in Streamflow

	Area Inches	
	1958	1959
May	0.09	0.25
June	1.27	0.09
July	1.60	0.58

The comparison is complicated by the fact that precipitation in June and July of 1958 was far above that in the same months of 1959. Additional records will have to be obtained before the rate of recovery after logging can be determined more precisely.

Streamflow for July, 1959 gives a first comparison of the effects of the different cutting practices upon quantity of flow:

	Watershed Treatment			
	Commercial clearcut	Diameter limit	Extensive selection	Intensive selection
Volume removed MBF/A (cut and culled)	9.0	4.3	3.5	1.8
July increase in flow--area inches (measured flow minus predicted)	0.58	0.44	0.18	0.03
Increase in flow as percent of predicted flow	387%	244%	49%	12%

Increases for the commercial clearcut and diameter limit cut were significant at the 5 percent level; increases for the two selection cuts were not significant. However, a definite pattern is apparent.

Soil Moisture and Water Quality Sampling

Some soil-moisture measurements have been made this summer and water quality sampling is continuing. Analysis has not proceeded far enough for a report on these at this time.

Miscellaneous

A records storage vault adjacent to the Fernow office building is nearing completion. This is a welcome addition as our basic data is building up beyond the capacity of our fire-resistant file.

West Virginia had the pleasure this year of acting as host to the annual meeting of the Northeastern Forest Soils Conference at the Blackwater Falls State Park. One day was spent on the Fernow Experimental Forest looking at site work.

Ken Reinhart and Carl Barr held a training session and laid out a logging road on the Camp Dawson (West Virginia National Guard) watershed.

The past 6 months have brought a large number of group and individual visits to the Fernow Experimental Forest. During this period we have been host to approximately 575 people involved in about 50 show-me trips.

Carl Barr and Wilfred Mitchell held a training session on logging road location for West Virginia Conservation Commission personnel at the Greenbrier State Park.

Dick Trimble discussed the results of the Center's watershed research studies at the annual meeting of the West Virginia Chamber of Commerce at White Sulphur Springs.

Dick Trimble spent a day on the Smithfield, Pa. watershed with consulting forester Tom Clark appraising the risk to the watershed involved in prospective logging of the area.

LACONIA RESEARCH CENTER

Weir Construction

Our weir construction program entered a new phase when we placed construction of weir #4 in the hands of a contractor. An idealized shape and size of weir was designed to fit the surficial characteristics of the stream channel prior to intensive excavation. Realizing that the size and shape of the weir would very likely change depending on the topography, soil, and bedrock characteristics after excavation, the contract was arranged so the bidders based their price on a cubic yard basis for unclassified excavation, concrete, reinforcing steel, and rock retaining walls. Items such as the gage house and weir blade were bid on a lump sum basis. Although the weir by contract will cost more than constructing it ourselves, we feel the time saved for research activities may well be worth it. Excavation for the weir is done and the weir should be operating by the last of October.

Humus Studies

This summer, humus measurements were taken in cutting plots in the northern hardwood forest of the Bartlett Experimental Forest. The data, summarized below, point out a trend. Average depth of the H-layer of humus was greatest on the uncut plots--least on the clearcut plots. The soil type was a podzol with a distinct mor-type humus.

Plot	Treatment	Litter and humus depths (inches)		
		L	F	H
1	Selectively cut about 1875. Clearcut in 1935.	.32	.51	2.05
2	Selectively cut about 1875. 30 percent selection cut in 1934.	.70	.80	2.27
3	Selectively cut about 1875. Uncut.	.51	.72	2.33
4	Clearcut about 1875. Clearcut again in 1939.	.52	.50	2.35
5	Clearcut about 1875. 40 percent thinning in 1937.	.42	.44	2.95
6	Clearcut about 1875. Uncut.	.48	.41	3.37

The difference in H-layer between clearcut plot 4 and uncut plot 6, 1.02 inches, was significant at the 5 percent level. The difference between clearcut plot 1 and uncut plot was not significant. Plots 1-3 are at a higher elevation and steeper slope, than plots 4-6, and site quality is not as good.

Bark Color and Snow Melt

Snow ring melt around tree trunks is a common sight during the spring melt period. A study was made to determine if the color of tree bark influenced the rate of this snow melt. Measurements were made on 30 trees; 10 trees had boles painted black, 10 trees painted white, and 10 trees were unpainted. Results showed no significant difference in the size of snow melt rings between the black, white and unpainted trees. A distinct relationship was observed between rate of snow melt and size of stem--snow melt around large stems was greater than melt around small stems.

Suspended Sediment Sampler

Several automatic sediment samplers, developed on the Fernow Experimental Forest, were installed this summer. These samplers will enable us to obtain water samples at any predetermined stage height. Because most of the soils at Hubbard Brook are sandy, the peak load of suspended sediment occurs for only a short time and then drops out of suspension. By the time a man reaches the sampling point, the water has very likely cleared up. The St. Anthony Falls sampler is not very

efficient in turbulent streams; other samplers require electric motors and timers. The "Rube Goldberg" sampler described here can be made from readily available material.

A flume diverts a portion of the streamflow into a collecting device. This device consists of a one-inch hose attached to a quart plastic bottle, both strapped to a one-inch-wide board. This board is balanced from a pivot provided by a frame. When the apparatus is in sampling position the hose rests in the flume and water runs into the bottle. As the bottle fills, its weight tips the hose opening upward out of the flume. In the ready position, prior to sampling, the board, hose, and empty bottle are held from falling into the flume by a wire which leads to a simple trigger mechanism. This trigger is attached to a length of sail cord which leads by pulleys to a tripping bucket near the front of the weir pond. The cord is tied to the bucket, a five-quart can filled partly with cement that floats about one inch above the water. Taut vertical wires mounted adjacent to the side wall of the weir pass through vertical tubes soldered to the bucket. These wires permit the bucket to move up and down but not laterally. As the water rises during storms, the bucket floats up until it hits a stopper. This stopper is an adjustable metal rod which prevents the bucket from rising beyond a predetermined stage height. Since the bucket cannot rise past the stopper, water fills the bucket and it sinks to the bottom. This pulls the cord to the trigger and activates the sampler. (If you can't get this at first reading, we're writing it up with diagrams in a Station Paper).

With one sampling rig and tripping bucket, it is possible to obtain samples at different stages of flow merely by changing the height of the stopper. If samples are to be taken at several stages during one storm, a battery of samplers can be built, each sampling rig requiring its own tripping bucket. The tripping-bucket device is also used to raise trash screens away from the v-notch when the head reaches 0.2 feet.

Miscellaneous

Tony Federer, our student trainee for the past two summers, was graduated from the Forestry School at the University of Massachusetts in June as top man in his class. Tony has departed this fall to the University of Wisconsin where he will start graduate work for a Ph.D. in soil physics and meteorology.

Work has started on our soils laboratory in the basement of the Forestry Building in Laconia. The laboratory should be completed in the next few months.

We are now working out of three trailers set up on our administrative site at Hubbard Brook rather than the rented cottage we formerly occupied. One trailer is used as an office, a second as an overnight

bunkhouse, and the third is for storage. The barn (inherited with the administrative site property last fall) has been modified to serve as a garage and workshop.

We played host to five groups this summer: Agricultural Stabilization and Conservation Committee for New Hampshire, Dartmouth College ecology class, University of Maine foresters, Lost River conservation camp for teachers, and University of New Hampshire foresters.

Director Marquis and Bob Bain toured our field installations. Bill Reifsnyder of Yale Forestry School was here on a work visit advising us on our meteorological problems.

NEW LISBON RESEARCH CENTER

General

The transfer of watershed management activities from the Kingston Research Center to New Lisbon was more or less completed at the end of April. Irv Reigner arrived with some equipment, voluminous files, and a mass of data collected in the past 10 years in watershed work at Dilldown and at the Pocono Experimental Forest.

He was met by friendly Jerseyites and, unexpectedly, by a soil moisture study that Howard Lull and Si Little had just cooked up and installed. More on this later. Since then, Reigner has been familiarizing himself with his new location and with the two new cooperative projects, Baltimore and Newark Watersheds, that have become the responsibility of this Center. An invitation to join a group of ARS and SCS personnel in a trip through New Jersey was cheerfully accepted. The tour visited examples of soil and water conservation practices and research projects and was quite informative. The summer meeting of the Cranberry Growers Association, a group highly interested in water, was also very educational.

The Soil Moisture Study

Although most everyone realizes that the pine forest uses large quantities of water, this project will show how much it uses as compared with blueberry ground cover and with water losses from a bare area.

Four plots have been established in a young pine stand on the Lebanon Experimental Forest, close to the office. Four other plots are located nearby on which all vegetation has been removed. Gravimetric soil moisture sampling done frequently this summer measured the moisture extraction by each condition. Analysis of data is far from complete but as expected, the pine forest has used a significantly greater amount of water than was lost by evaporation from the bare area.

The study will continue for two more years with increasingly complex comparisons. Next year, some of the bare plots will be allowed to revegetate with blueberry and sedge groundcover, while the pine density will be decreased on some of the pine plots.

A series of groundwater wells has been established in the plot area to measure possible differences in groundwater level due to soil moisture or vegetation differences--and also to make certain that groundwater is not affecting soil moisture.

Newark Watersheds

As this summer was the initiation period for the new weirs, considerable effort was made to work out the bugs that always inhabit a new installation. Wing walls had to be constructed back of two of the weirs to prevent flow around the weir boxes in loose back fill. Smaller leaks at the third weir were recently discovered. We will probably try to correct this problem with bentonite.

The first exposure of the research watersheds and installation to public view will take place October 2. The N. J. Chapter of the Society of American Foresters will visit the Newark Watershed and will observe the research project.

Baltimore Watershed

The third Baltimore weir has recently been completed and is a radical departure from other weirs in the Northeast. Although it has a standard 120° V-notch sharp-crested blade mounted in a box similar to many others, the box is made of wood and is lined with a sheet of black vinyl film, 22 feet wide and 44 feet long. Lou Ningard, the Superintendent of the Baltimore watersheds, has always been sympathetic with our desire to develop a cheaper, simpler weir. Lou designed this box which can be constructed without heavy equipment, if necessary, and with materials which might be obtained in a back country area near a weir location.

Walter Sushko, the Baltimore watershed forester and Irv Reigner have prepared a manuscript describing the Baltimore watersheds, the management practices being carried on, and the research in progress. It is now being edited and will be submitted for publication to one of the conservation periodicals.

Dilldown Watershed

Although the calibration period of this study has been completed, a sizeable part of the watershed still has not been converted from scrub oak to high forest species. Thus, research is still continuing in a small way. It appears that subsequent conversions must be accomplished by

direct seeding, as the remaining area is too rocky to plant. In addition, the rock eliminates the possibility of mechanical site preparation.

As direct seeding almost certainly requires site preparation, the only obvious solution is some form of chemical treatment. A small trial was made last summer using a tractor mounted low-volume sprayer. Results of this test were not encouraging; a fair kill was obtained by the highest concentration, 4 lbs. of 2,4,5-T per acre in the tracks made by the crawler-type tractor. But from the results of the 1956 mistblower trials, better results could be obtained by a directed mistblower treatment.

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Frost and forest soil. Howard W. Lull and Robert S. Pierce.

Management of forested watershed lands for the City of Baltimore. Walter C. Sushko and Irvin C. Reigner

A time-scale corrector for use in adjusting streamflow charts. Raymond W. Lavigne.

The problem of stones in soil-moisture measurement. Kenneth G. Reinhart.

A simple filter for small streams. Kenneth G. Reinhart.

PACIFIC NORTHWEST FOREST AND RANGE
EXPERIMENT STATION

Semi-annual Report
Watershed Management Research

April 1, 1959 - September 30, 1959

GENERAL

One of the most interesting events of the past six months was a visit by the national Forest Research Advisory Committee during the last week in August when the PNW Station was host for their annual meeting. It was also very demanding of time on the part of personnel in the Corvallis and Bend centers. Our watershed story, one of the highlights of their stop at H. J. Andrews Experimental Forest, was ably handled by Jack Rothacher.

Division Meeting

In May we held a meeting at Blue River, Oregon to review the status of our watershed research program and do some joint thinking about future activities. It was the first such meeting since we began operating in 1955 and proved to be a worthwhile session. We plan to hold something of this sort every year, if possible. We figure there are valuable benefits in training, improved coordination, and esprit de corps.

Aerial Gravity Cable Logging

The American logger's answer to the Wyssen Skyline Crane is in operation on a Forest Service timber sale in the northern Cascades near Darrington, Washington. The successful bidder was faced with a stipulation in the contract calling for logging by an aerial gravity cable system. Instead of using Wyssen's machine as many interested observers expected, he devised his own and had it built by Skagit Steel and Iron Works in nearby Sedro-Woolley.

A unique feature is the carriage which contains a radio-controlled diesel motor that operates 400 feet of yarding cable. Log loads can be raised from the ground at the yarding point and lowered at the landing by a signal received from a small portable radio. The loaded carriage descends on a skyline by gravity under control supplied by a snubbing winch located at the uphill end of the logging unit. Up to 12 tons of logs can be handled per turn, giving it more capacity than anything yet demonstrated by Wyssen in this country.

In early September several people from our watershed research division visited the operation and saw it logging at the rate of 50 MBM per day without a log touching the ground between yarding and landing points. However, most observers, including ourselves, have adopted a wait-and-see attitude regarding the economics of such an operation. Wyssen could still come out ahead on that score.

CORVALLIS RESEARCH CENTER

-- by Jack Rothacher

Small Watershed Studies (FS-1-w5-2), FS-1-w7-6)

With the completion of 1.7 miles of logging roads in Experimental Watershed #3 on the Andrews Experimental Forest, the treatment phase of this study has begun. Cross sections of the completed road indicate that we have disturbed a total of 15.6 acres or 6.2 percent of the 250-acre drainage. Classification of the disturbance is as follows:

Roadbed	5.1 Acres	2.0 percent
Backslopes	2.5 Acres	1.0 percent
Fill slopes	8.0 Acres	3.2 percent
	15.6 Acres	6.2 percent

On the upper and lower roads where topography made road building easy, average disturbed width is 52 and 60 feet respectively. The middle road, which crosses steep side slopes and contains two large fills, averages 94 feet in width.

The first heavy rains, unusual for September, totalled 3.1 inches in 4 days with 1.6 inches falling on the fourth day. This was a showery storm with intensities in excess of 3/4 inch per hour. Toward the end of the storm, showers created one small mudflow into the main creek resulting in a suspended sediment load of over 1,000 parts per million as measured at the gaging station 5/8ths of a mile downstream. This was in a stream which has never before produced over 200 ppm, even in storms totalling 6.25 inches in a day. The adjacent untreated watersheds remained clear with probably not more than 10-15 ppm.

We estimate that 5 cubic feet of soil would keep this stream (flowing at 3cfs) muddy at 1000 ppm for about 1 hour. Source of sediment was a single 50-foot section of the middle road where topography is steep near a crossing of the main stream. Soils here are derived from tuffaceous deposits, high in clay and silt fractions, which seem to "melt" under heavy rains.

The upper and lower roads, where topography is more gentle and construction was easy, have as yet produced no sediment that has reached the stream.

We are looking forward to an interesting winter collecting many sediment samples.

Cooperative Studies (FS-1-w4-2)

We are cooperating with Prof. R. L. Wilson of Oregon State College who is studying the sources of erosion from roads for a doctorate thesis problem. While his work to date has been largely testing of techniques, he has found that the soil moves off some of our cut banks on the Andrews at the tremendous rate of about 80 tons per acre per year. We were not too surprised to learn that most of this soil movement occurs during the dry summer months when exposed subsoil is drying and shrinking. This dry ravel, of course, collects in the ditches and often gets into the stream the next winter. When wet, these clayey soils stick together and soil movement is greatly reduced. Fortunately, all our soils are not moving this rapidly. Some cut banks yielded only a few pounds of soil at a rate as low as 1/3 of a ton per acre per year.

Revegetating Road Banks (FS-1-w6-3)

Since soil movement from road cuts is quite obvious in places and requires considerable maintenance of ditches and culverts, Region Six has become increasingly interested in vegetation of roadbanks. A trial seeding was initiated this year in cooperation with the Blue River Ranger District. We followed a study plan prepared by Ned Bethlahmy for a similar trial that was started in the Bull Run area. The studies showed that 3/4 ton of straw mulch, 10 pounds of a mixture of grass seed, and an adequate supply of fertilizer gave a good stand of grass in one season. The applications of 16-20-0 fertilizer ranged from 100 to 500 pounds per acre with best results from the heavier applications.

While foresters are concerned that in some areas the grasses may spread to the cutover units and offer competition to conifer reproduction, we at least know we can control much of the soil movement caused by dry ravel and beating rain. This type of vegetation does not control mass soil movements such as slumps and slides.

ROSEBURG RESEARCH CENTER

-- by H. G. Herring

Tractor Skid-Road Erosion (FS-1-w4-2)

The outstanding piece of knowledge gleaned from this study so far is that profile measurements of skid roads do not accurately evaluate erosion. In the summer of 1958, 12 erosion plots were established on new skid roads. Detailed profile measurements were made every twenty feet on all twelve. (The plots ranged from 76 to 180 feet in length, averaged about 13 feet in width and were on slopes of 11 to 46 percent.)

In addition to the profile measurements, trough and drum catchments equipped with flow dividers were used on four plots to sample soil actually carried off the plot.

Table 1 shows the first-year results for the four plots which had both types of installation. The catchments had insufficient capacity and some runoff was lost. An approximation of total soil moved off the plots can be obtained from the amounts of soil actually measured in the catchments by assuming that surface runoff was about 65 percent of total precipitation. For sake of comparison, the hypothetical soil loss for 100 percent runoff was also calculated. This procedure admittedly leaves much to be desired, but it does permit a gross comparison of the profile method versus the collection method.

Table 1

Plot No.	Soil transported off plots[1/]			Soil loss from profile measurements
	Actually Measured	Expanded for 65% runoff	Expanded for 100% runoff	
	Cu. ft.[2/]	Cu. ft.	Cu. ft.	Cu. ft.
1	4.2	12.3	18.9	103.6
2	1.2	2.7	4.1	24.2
5	0.8	2.1	3.2	10.8
6	15.2	19.9	30.4	75.4

1/ Catchments inadequate. Quantities measured have been adjusted proportionally to estimate true values, assuming both 65 percent and 100 percent surface runoff.

2/ Sediment was weighed and a correction was made for moisture content. The resulting values were converted to cu. ft., assuming a bulk density of 90 lbs./cu. ft.

It can be seen that the profile measurements resulted in exaggerated values of soil loss, even assuming 100 percent surface runoff. Furthermore, the difference is widely variable, precluding the possibility of using the profile data even relatively.

This difference can be attributed to the condition of the skid road surface following dry-season logging. A layer of dust, from 4 to 6 inches deep, is developed, which the first fall rains settle and compact, causing a lowering of the soil surface with no attendant soil loss. Profile measurements for subsequent years should be more reliable, but since we think most soil loss occurs the first winter in most cases, the profile method has been discarded for subsequent plots.

The failure of the profile method and the overflow of the catchment drums has made the first year's results questionable. We hope to be able to use some of the information to interpret results of other studies, however.

During the past summer the drum-type flow divider was redesigned to give it a larger capacity. We now have a model that has an effective capacity of 400 to 650 cu. ft., with a maximum input rate of about 0.1 cfs. Six of these units have been installed on new skid roads, and the four old models on the original plots have been replaced.

Experimental Watersheds

The design of the access road to the South Umpqua Experimental Forest gaging sites has recently been approved. There was considerable discussion for a time as to the best location in several places. A cost analysis appeared to favor one location whereas from a watershed management standpoint a different location is desirable. We finally got it where we wanted it, but some other factors had to be introduced, such as convenience for gage servicing and show-me trips.

This matter points out that one of the biggest watershed problems we have is to justify the additional expense of practices we recommend. We can recommend what we consider to be desirable watershed management practices as long as we can find people to listen (or read), but until we can show that costs are balanced by potential benefits, both tangible or intangible, we will have very few of our recommendations adopted voluntarily. Ultimately we must be able to predict the kind and degree of damages that may occur from a given action, and the probability that such damages will occur. This will require a much more detailed knowledge of stream hydraulics and soil hydrology than we now have, but optimum utilization of our natural resources cannot be achieved until we have that knowledge. Perhaps in the interim we need an arbitrary scale of values for use within the service to compare alternative courses of action. Such a scale would provide an objective, if arbitrary, basis for reconciliation of differences of opinion in cases of road location and design, and logging layouts and methods.

LA GRANDE RESEARCH CENTER

-- by Dan Bishop

Soil Moisture Study - Lodgepole Pine (FS-1-w1-6)

We have completed a growth season's measurement of soil moisture in three lodgepole stands. Sampling has been conducted in 1/16-acre plots - one in each stand. The soil is a pumicite layer 24-30 inches deep lying on a residual soil developed from basalt. Measurements were

taken in three zones, the upper two (A & B) in the pumicite, and the third (C) in the residual soil. At the beginning of the growing season (April 16) A and B zones averaged between 60 and 65 percent moisture content based on oven-dry weight. In zone C, moisture content averaged 33 percent. By late September moisture content in A and B zones was reduced to 14 percent and in zone C, to 10 percent.

Next year we plan to remove lodgepole pine from half of each plot to eliminate the major transpiration losses. Soil moisture samples will be continued for the second growing season. We will also take bulk density samples during the coming spring to convert moisture measurements to a volume basis.

Interception and Stemflow (FS-1-w1-3)

In a study related to the soil moisture study described above, we are obtaining data on interception and stemflow in lodgepole pine during the growing season. Measurements are being made on the three stands from which soil moisture samples are taken.

Interception has proven to be highly variable during the growing season. An average for the 1959 season is 28.1 percent of gross rainfall.

Very little stemflow was observed during this period. Only two measurements showed significant amounts and in these cases the maximum volume was less than 1/2 gallon. Our data so far indicate that stemflow is not a significant factor in expressing total water reaching the ground level of lodgepole stands, such as those we are measuring.

Starkey Soil Survey

This summer, with our help, the Soil Conservation Service completed a soil survey of the 27,000 acres in Starkey Experimental Forest and Range. A report is being prepared and will be available soon. Starkey is the first large experimental forest in this region to receive a complete survey carried out in accordance with national soil survey standards.

WENATCHEE RESEARCH CENTER

-- by Dave Wooldridge

Entiat Experimental Watersheds

The construction crew of Wooldridge, Fredriksen, and Balci (latter two are students from the University of Washington) has completed the major portion of the construction work on the Burns Creek weir in the Entiat Watershed. Final concrete pour was made September 24.

The major remaining task is construction of a gage house and installation of a water-stage recording unit.

A cutoff wall 35 feet long and 6 feet high was constructed of reinforced masonry (concrete blocks) on a poured concrete footing. As yet, the stilling pond has not been filled so we don't know how much the cutoff wall resembles a sieve. At the writing of our next report we will be in a better position to evaluate the quality of our construction effort and the adequacy of concrete blocks and also to comment on problems of stream gaging in an area of 3 to 5 feet of snow accumulation and -20° F. minimum temperatures.

Temperature Measuring Apparatus

A design has been worked out and a trial instrument constructed for accurate (within 1/2° F.) temperature measurements from -30° F. to +200° F. A Fenwall thermistor is being used as the temperature-sensitive element. Thermistors are available in a variety of sizes and shapes, which make them quite suitable for soils and other ecological work. We will construct the final instrument and field test it this fall. Further comment will be offered in our spring report.

BULL RUN PROJECT

-- by Nedavia Bethlahmy

Soil Moisture Study - Old Growth Douglas-fir (FS-1-w1-6)

How much water is used by a mature Douglas-fir forest? If the forest were cut down, what changes would take place in the soil moisture regime? These questions will be answered by an experiment started this summer. Certain areas in the Bull Run watershed will be logged next year in small blocks. Until then, and continuing after the logging operation, monthly soil moisture samples will be taken in the areas to be logged and in adjacent areas that will remain unlogged. In addition, monthly soil moisture samples are being taken in both units that have already been logged and in contiguous unlogged areas. Altogether, only five paired areas are being sampled, but the field and laboratory work involved is a big load and has cut down considerably on the time available for other studies.

Roadbank Seeding (FS-1-w6-3)

Nine miles of road-banks were seeded experimentally in the spring. The banks were first mulched, then seeded and fertilized. The sole variable was quantity of fertilizer. A commercial fertilizer (16:20:0) was applied at rates of 100, 300, and 500 lbs./acre. Preliminary analysis indicates that best results, by far, are obtained with the heaviest

application of fertilizer. The experiment will be extended this fall on a recently completed road, but only the 300 and 500 lbs./acre applications will be tested.

Uniform Land Management Policies?

A management problem has developed in a municipal watershed near Portland. The solution is of regional, if not national, significance. The mayor of Oregon City has two jars of water on his desk: one is clear and is marked "Before"; the other is clouded with silt and marked "After". The problem? Oregon City derives its water from forested watersheds managed by both the Forest Service and the BLM. The Forest Service has logged the area for years (without any complaints) under strict regulations. Lately, the BLM has been selling its timber, but without any special restrictions. The deleterious effects of such logging have shown up in the city's water supply, and of course, the Forest Service has been blamed. Obviously, a watershed cannot be both managed and mismanaged at one and the same time -- a clear case of "a house divided".

Miscellaneous

During the summer we were hosts to visitors from Ghana, India, and Korea. Such visits are mutually beneficial.

Bethlahmy was elected chairman of the executive council of the regional AGU, a job that demands much effort and time.

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SEMIANNUAL REPORT

Division of Watershed Management Research
Pacific Southwest Forest and Range Experiment Station

April through September 1959

GENERAL

The Division's responsibilities and activities are being extended westward to the State of Hawaii. Funds were appropriated by the new State for watershed research, and an agreement was completed to start cooperative studies. Walt Hopkins made an inspection of key Hawaiian watersheds and related land management problems with Robert Nelson in early July.

Initial investigation dealing with soils and soil moisture will be carried on jointly with the Southern Station (Waterways Experiment Station at Vicksburg).

PERSONNEL

Steve C. Brodie, one of our outstanding young men at the Central Sierra Snow Laboratory, fell from a tree August 27 and died the following day.

Ray Rice and Johnnie Andre' are enrolled in graduate school at the University of California. Each is carrying on one study in snow research on a part time employment basis.

Sam Krammes returned from a year of graduate study at the University of Montana and is temporarily assigned to the Angeles N. F., and is assisting in soil stabilization planning for the Los Angeles River Flood Prevention Project.

PUBLICATIONS

Manuscripts Published

Anderson, H. W.
Progress report, 1957-58, cooperative snow management research. CF&RES, 56 pp. illus., proc., June 30, 1958.

Objectives, methods, plans and results of snow management studies in the headwaters of five major California river basins are summarized and indexed. Basic meteorology, snow, sediment, and streamflow data are included.

Anderson, H. W.
Rain-snow flood sources, meteorologically defined. Presented at Amer. Meteorol. Soc. Session of AAAS at Logan, Utah, June 16, 1958. (Abstract) Bul. Amer. Meteorol. Soc. 39(3):174-5, 1958.

Flood peak discharges of 54 watersheds of the Willamette Basin, Oregon, in 43 storms were related by multiple regression analysis to five meteorological variables and four watershed variables. The results were interpreted in terms of the relative frequency of floods in various elevation zones of western Oregon. Loan copy of manuscript is available for inspection.

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Water yield control through management in snow pack watersheds. Proc. First Intersociety Conf. on Irrig. and Drainage, pp. 13-18, March 1959.

Abstracted in Oct.-Mar. 1958 Semiannual Report, CAL-3.

_____ and R. L. Hobba
Forest effects on floods in northwestern United States. Submitted for publication in Proc. Symposium on Forests and Water, Hannover-Munden, Germany, Sept. 1959.

The effects of reduction in stocking and of logging and burning on flood peak discharges for rain-on-snow and snowmelt floods were evaluated. Methods of multiple regression, covariance, and double-mass analysis were used.

_____ and Lucille G. Richards
Progress report, 1958-59, cooperative snow management research. PSWF&RES, pp. 57-94, June 30, 1959.

Results of the 18 studies of snow zone hydrology during 1958-59 are summarized and future plans in each study are outlined. Basic meteorology, snow measurements, and streamflow of some Sierra sites during 1958-59 are given.

Ashby, W. C. and H. Hellmers
Flowering and growth responses to photoperiod and temperature for six southern California grasses. The Botanical Gazette, Vol. 120, No. 3, March 1959, pp. 151-157, illus.

Both temperature and photoperiod were found to markedly affect the growth and flowering of the annual and perennial grasses studied.

Knoerr, K. R.

Summer evapotranspiration measurements using a radioactive soil moisture probe. Presented at SW Pac. Meeting Amer. Geophys. Union, 1959. (Abstract) Jour. Geophys. Res. 64(6): 691, 1959.

Summer soil moisture losses and losses of summer precipitation were measured at 45 sites in the Castle Creek Basin. The first analysis indicates that for a 75-day period--July 1 to October 15, 1958--losses from a soil 4-foot deep were as follows: for old growth Red Fir forests, 5.1 inches; for young Red Fir forests, 4.8 inches; for Wyethia (wild sunflower), 3.5 inches; and for bare ground, 1.3 inches. An additional loss of 2.0 inches of summer precipitation occurred in the period.

Patric, J. H.

Increasing water yield in southern California mountains. Jour. of Amer. Water Works Assn., Vol. 51, No. 4, April 1959, pp. 474-480, illus.

Discussion of watershed management research to increase water yield conducted on the San Dimas Experimental Forest.

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Sulfur dioxide as a defoliant of chaparral plants. Jour. of Forestry, Vol. 57, No. 6, June 1959, pp. 437-438, illus.

Sulfur dioxide gas proved to be an effective defoliant of several chaparral plants--a possible means of reducing water loss by transpiration.

Sinclair, J. D. and J. H. Patric

The San Dimas disturbed soil lysimeters. Submitted for publication in Proc. Symposium on Forest and Water, Hannover-Munden, Germany, September 1959.

Describes the San Dimas large confined and unconfined lysimeters, compares the growth of pine in the two types and discusses the influence of plant species on rainfall disposition in the confined lysimeters.

West, A. J. and K. R. Knoerr

Water losses in the Sierra Nevada. Jour. Amer. Water Works Assoc. 51(4):481-88, 1959.

Some results were summarized in April-Sept. 1958 Semi-annual Report, CAL-7.

Manuscripts Accepted for Publication

Anderson, H. W. and C. H. Gleason

Logging effects on snow, soil moisture and water losses. Presented at Western Snow Conference, 1959. Submitted for publication in Proceedings, 1959.

Water yield in the Sierra Nevada as affected by three types of logging was studied. Snow accumulation as affected by natural forests and openings and by three kinds of slash disposal are reported.

Anonymous

Managing our snow for a better water supply. To be published jointly by State and Station. 17 pp.

A "picture-book" of the California Cooperative Snow Management Research program.

Clark, Frank G.

A hemispherical forest photocanopymeter. To appear as a Station Research Note.

Summarized in Oct.-March 1959 Semiannual Report, CAL-6.

Hellmers, H. and J. M. Kelleher

Ceanothus Leucordermis and soil nitrogen in southern California mountains. Forest Science.

Chaparral whitethorn was found to improve site conditions by increasing nitrogen in three mountain soils.

Hopkins, Walt

Snow management research in the Sierra Nevada--a review and a look ahead. Submitted to Western Snow Conference for publication in Proceedings, 1959.

The pioneering work of Dr. J. E. Church on snow research in the Sierra Nevada is reviewed in the light of its contribution to current research programs.

Reimann, Lyle F.

Mountain evaporation--data from the San Dimas Experimental Forest at elevations of 1,500 to 5,100 feet.

Presents monthly summaries of evaporation records from four elevations.

Reimann, Lyle F.

Mountain temperatures--twenty-five years of data from the San Dimas Experimental Forest.

Contains summaries of monthly, annual mean, and highest and lowest air temperatures recorded at eight elevations.

_____ and Everett L. Hamilton

Four hundred sixty storms--twenty-five years of rainfall data from the San Dimas Experimental Forest.

Includes summaries of daily and annual amounts of rainfall, maximum rainfall rates and other storm data obtained at Tanbark Flat.

Richards, Lucille G.

Forest density, openings, ground cover and slopes in the snow zone of the Sierra west side. To appear as a Station Research Note.

An inventory of the forest and land conditions and topography of the Sierra west side above 5,000 feet elevation is summarized. Air photographs were interpreted of 331 40-acre plots which constituted the sample.

West, A. J.

Snow evaporation and condensation. Presented at the Western Snow Conference, 1959. Submitted to them for publication in Proceedings, 1959.

Snow evaporation results at and near the Central Sierra Snow Laboratory in the winter of 1958 and 1958-59 are given, together with relationship of evaporation to wind and atmospheric moisture. Evaporation in forests, forest openings and exposed sites of various aspects are compared.

CURRENT RESEARCH

Snow Zone Hydrology Studies

Inventory of Sierra Hydrologic Characteristics

Lucille Richards' inventory of the forest and land conditions and topography of the Sierra west side above 5,000 feet elevation has been completed. The kinds of forests and their densities, sizes of openings and their ground conditions (brush, grass-herb, bare ground, or rock outcrop), have been determined from an air photo analysis of 331 systematically located 40-acre plots.

Among the highlights is the realization that we who seldom see more than the trees must learn to manage vast acreages of bare ground and brushlands.

	Percent of Area
Forested (Canopy cover greater than 15%) - - -	42
Non-forested	
Bare ground and rock - - - - - - - - - - - -	29
Brush covered - - - - - - - - - - - - - - -	17
Grass-herb - - - - - - - - - - - - - - - - -	7
Other, tallus, crops, lakes etc. - - - - - -	5
	100

Experimental Watersheds

Two more debris dams were constructed and gaging stations installed in the Onion Creek Experimental Forest. Streamflow and sediment measurements were initiated in these two watersheds in September 1958, bringing the total number of gaged and measured streams in experimental forests to ten.

Discharges are being computed from stage readings using the State's Bendix G-15 computer. We have made arrangements with the USGS to check the gaging stations and publish the discharge records in their regular Water Supply Papers.

Basic Meteorological and Snow Measurements

A special microvolt recording system has been installed at the CSSL Headquarters. The system provides automatic recording and tape punch output of as many as 144 micrometeorological elements every six minutes or each hour at our discretion. The system punches out identifiers ahead of each micrometeorological element so that the tapes may be fed directly into electronic computors for analyses. The system is still being "debugged" but promises to come into smooth and continuous operation soon.

The basic snow measurements studies included an analysis of the applicability of the median snow water content of a snow course in determining the average value of a course. In the test, the median of 5 points of a snow course correlated as well with streamflow as the mean of 19 points.

Snow in Openings and on Forested Slopes

Analyses were made of the data from 1958 snow accumulation and melt at 57 snow courses, showing snow accumulation and melt in the forests of various densities, in forest openings of various sizes, and on various slopes. The snow in various forest conditions (average for all slopes) at the time of maximum snow accumulation, about April 22, 1958, and again after about one-half to two-thirds of the snow had melted, June 1, 1958 are given in the following tabulation:

Forest Condition	Snow Water - Inches		
	April 22	June 1	Melt
In forest openings	63.2	26.8	36.4
In forest adjacent to openings	56.0	25.1	30.9
In dense forest (80-100%)	48.1	19.0	29.1
In moderate forests (50-80%)	50.3	25.0	25.3
In open forests (20-50%)	57.7	25.0	32.7

Note that the maximum snow on April 22 and still on June 1, 1958 was in forest openings; maximum melt occurred there too. Lower melt rates were found in forests, the least being in the forests of moderate density.

Moderately steep slopes (about 30 percent) were found to have higher melt rates than steeper or less steep slopes. Most rapid melt rates occurred on the south and west slopes. The suggestion that snow accumulation might be a maximum in L-shaped openings on east and west slopes was proposed. Differences in melt rate on various parts of forest openings were discussed in a paper summarized in the 1958 Proceedings of the Society of American Forestry, Salt Lake Meeting.

Snow accumulation and melt have been measured again during the winter of 1958-59 at these 57 snow courses. Photocanopy pictures have been taken at each of the 1,300 points involved; and have been interpreted for the 400 points with maximum differences in forest canopy. These data are now being analyzed to determine the variables that determine snow accumulation on various slopes.

Winter Evapotranspiration in Relation to Forest and Terrain

Snow evaporation results in the winters of 1958 and 1959, together with relationship of the evaporation to wind and atmospheric moisture were studied at the Central Sierra Snow Laboratory. Evaporation from the snow was measured daily in a small forest opening and in a 80 percent dense forest, at an elevation of 6,700 feet. Evaporation from January through June 1959 totaled 1.7 in the forest openings and 0.9 inches in the forest itself. In a short term study the snow evaporation in a meadow was one and a half times that of the small openings and snow evaporation on exposed ridge tops was as much as three times that of the openings. In mid-June of 1958 a snow patch was gaining nearly 3/100 of an inch of water per day due to condensation.

Sagehen Study of Streamflow, Sedimentation, and Fish Habitat

Summer soil moisture losses were measured in a brush field being converted to a pine forest. In 1957 the brush on a 12 percent south slope was removed by bulldozing, and windrowed. In the spring of 1958 the area was planted with pine. Summer soil losses in the period July 24 to September 30, 1958 for a 4-foot and 7-foot soil depth in the converted area and in adjacent brush are given in the following tabulation:

Condition	Soil Moisture Loss - Inches	
	4-foot Soil	7-foot Soil
Converted Brush (to small pine)	0.7	0.8
Unconverted Brush	3.4	6.0
Difference	2.7	5.2

The conversion saved 2.7 inches of water for a 4-foot soil and nearly double this amount in the soils 7 feet deep.

As far as could be determined by indicators of erosion, the windrowed brush was effective in stopping erosion; apparently no erosion reached natural streams.

Erodibility of Wildland Soils; Relation to Sedimentation

Soil samples were taken at 177 standardized sites (same slope, aspect, precipitation and elevation) differing only in geology, in the wildlands of northern and central California. Physical characteristics of these soils are being determined in the laboratory, in an attempt to obtain indexes of the erodibility of soils developed on various parent rock materials.

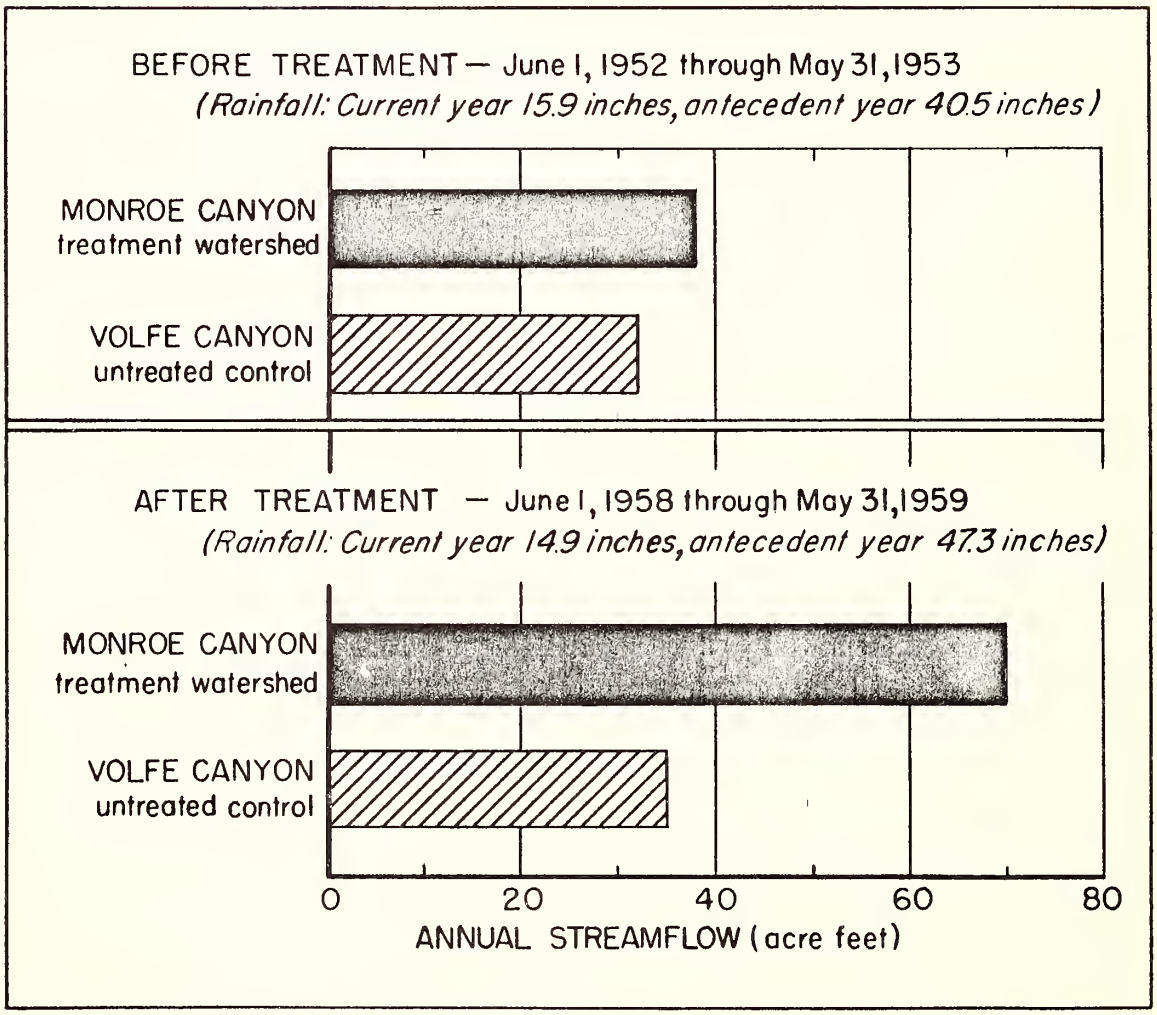


Figure 1.--Streamflow yields from Monroe and Volfe watersheds, San Dimas Experimental Forest, for comparable years before and after removal of canyon bottom tree and shrub growth in Monroe.

Mechanical analyses of these samples have been completed as part of the plan for testing the relation of sediment production of watersheds to the physical characteristics of soils.

San Dimas Experimental Forest

Watershed Management Tests to Increase Water Yield

The second stage of clearing woodland-riparian vegetation in Monroe Canyon was completed in April 1959. This year Forest Service crews removed brush and felled over 3,200 trees on 23 acres, bringing the total cleared area to 38 acres.

First year results indicate that removal of vegetation in Monroe Canyon has increased streamflow. The effects of the clearing were computed by comparing the flow from Monroe Canyon (875 acres) with that of adjacent untreated Volfe Canyon (740 acres), for years of similar rainfall before and after treatment.

Streamflow yields from Monroe and Volfe are usually about the same, but Monroe's flow for the first test year after treatment was about twice that of Volfe. From June 1, 1958 through May 31, 1959 the measured flow from Monroe was 70 acre-feet. This flow was approximately 30 feet more than predicted if the canyon bottom trees and brush had not been removed--an increase of 0.8 acre-foot per acre cleared. Sixteen acre-feet of the increase occurred during the first dry period starting in June 1958, 11 feet during the 1958-59 rainy period, and 3 feet through May of the current dry period.

Erosion effects of the canyon bottom clearing in Monroe watershed are being studied cooperatively with the Los Angeles County Flood Control District. Cross-sections were surveyed in the Monroe channel and in the untreated channel of Volfe watershed from which changes in configuration of the channels can be determined and quantities of erosion or deposition estimated.

The 41 acres of brush on side slopes with deep soil in 100 acre Bell Watershed No 2, were again sprayed by helicopter using a 2,4-D-2,4,5-T mixture in May 1959. The cost this year was about $24 per acre compared to $30.50 last year. A good leaf kill has resulted from each spraying, but much of the brush is still alive, and it is doubtful if even the third spraying, planned for next year, will provide the brush kill needed to meet study objectives. Hand clearing, though quite impractical, may be necessary.

Streamflow from Bell No. 2 has been continuous since the first spraying, but intermittent in the control watershed, Bell No. 3. Based upon rainfall and streamflow records, the flow from the treated watershed would have ceased about September 15, 1958 and about July 1, 1959 had the vegetation been undisturbed. Treatment effects have not yet been evaluated quantitatively.

Effect of Monroe Canyon Woodland-Riparian Clearing on Stream Temperatures

During two periods in late June and early July water and air temperatures were recorded in Monroe Canyon, in which 38 acres of woodland-riparian vegetation had been removed, and in untreated Volfe Canyon. In each canyon water temperatures were taken at the uppermost point where water surfaced in quantity and at the mouth of each canyon, approximately 6,000 feet downstream. In this short period of observation:

1. Groundwater emerged in each canyon at virtually identical temperatures.

2. Water temperatures at the mouth of the Monroe canyon were much higher than in untreated Volfe canyon. On each day of observation, the maximum at the mouth of the treated canyon was at least 20° F above the maximum at the point of surfacing. In the untreated canyon the difference was between 3° and 4° F.

3. Daily fluctuations also were much greater in the treated than in the untreated canyon. Fluctuations in the treated canyon ranged from 15° to 19° F., compared to 4° and 5° in the control watershed.

   Flow in the untreated canyon ceased in mid-July.

Water Use by Pine vs. Brush

Annual evaporative loss from a 30 year old coulter pine plantation and from a cover of dense brush at Tanbark Flat is summarized in the following table:

Dates	Rainfall	Annual evaporative loss	
		Pine	Brush
11/1/52-10/18/53	15.5	17.9	19.0
11/18/53-11/8/54	24.9	24.0	23.6
11/8/54-11/8/55	19.9	20.7	20.6
11/8/55-11/24/56	20.2	20.2	1/ 17.9

1/ Reduced due to drift of hormone herbicide during application on adjacent plots during summer and direct application of herbicide to brush during the fall.

Rainfall during these years was below the 28-inch average for the site. Runoff from the pine and brush plots was no more than a trace any year. In none of the years did moisture penetrate through the 9 feet of soil under the pine or 12 feet under the brush. During 1952-53 evapotranspiration exceeded rainfall due to a carryover of soil moisture from the preceeding year's 41 inches of rain. The greater use by the brush resulted from this carryover in the 9 to 12 foot soil depth.

Figure --Field equipment to measure rainfall interception by grass litter.

While total annual evapotranspiration losses were similar, there was considerable difference in rate of use during different seasons. During the wetting period of two similar years (11/8/54 to 5/9/55 and 11/8/55 to 5/10/56) average evapotranspiration loss from the pine plots was 12.9 inches. Loss from the brush plots for the same period averaged only 9.4 inches. These results substantiate lysimeter data which have shown that coulter pine uses more water during winter and early spring than brush species (CF&RES, Annual Report, 1956).

Rainfall Interception By Grass

Preparations are under way for the second rainy season's work on measurement of rainfall interception by grass, a special cooperative study with the California Division of Forestry. Sample sites have been enlarged to 5 x 5 feet each. As during the first season, metal collars 10 inches in diameter will be driven part way into the soil and a water-proof sealer (neoprene latex emulsion) applied to the soil surface after the grass cover has begun to develop. In order to enlarge the sample, three collars, instead of one, will be located in each sample site. A drain in the side of each collar will carry off combined throughfall and stemflow to a tipping bucket. Supplemental sprinkler irrigation will be used, if needed, in November and December to be sure of germination and establishment of a good grass cover.

In order to reduce our total dependence upon natural rainfall for interception studies, a "laboratory" approach is being adopted for the measurement of interception storage capacity. Grass of different species will be grown in small portable tanks in a greenhouse. After the young plants are well established, the soil surface will be sealed and the tanks moved into a "rain maker" apparatus for test runs. Since it will not be possible to duplicate natural climatic variables, we will be measuring interception storage only, rather than total interception loss. However, with this "laboratory" approach it should be possible to build up interception storage data for different species at different growth stages on a systematic year-round basis.

Measurements of rainfall interception by grass mulch will be continued and enlarged. As during the first year, samples of mulch have been carefully cut free from dead roots at the soil surface and transferred to metal pans. Drains in the bottom of each pan will be connected to collecting cans. Five such pans, which were in operation from January through May 1959, a period in which 10.60 inches of rain fell, caused interception losses of from 2.5 percent in very light mulch to 8.4 percent in heavy mulch.

MEETINGS

April 14.--Patric spoke on general conservation and work on the San Dimas Experimental Forest at the monthly meeting of the Glendora American Legion Post.

April 21-23.--Most of the snow team attended the Western Snow Conference in Reno. Two papers were presented and 43 attended the field trip which reviewed the snow research program at the Central Sierra Snow Laboratory.

May 7-9.--Anderson and Sinclair participated in the Project Leaders Conference held at Asilomar during which research planning and many other management problems were discussed.

May 20.--Rowe spoke to the Los Angeles County Sheriff's Posse Executive Committee on upstream watershed management in southern California.

June 8-12.--Storey and Osborne of the Washington Office, Hopkins, Anderson, Rowe and Court of the Watershed Management Research staff and Station Statistician O'Regan met and laid the groundwork for modernizing and improving watershed calibration and streamflow analyses.

July 29.--Knoerr spoke to the Alameda Kiwanis on Cooperative Snow Management Research in California.

COOPERATION

D. J. Finlayson and Wilbert Chung, engineers with the State Water Rights Board, were supplied hydrologic data pertinent to the Los Angeles City-San Fernando water dispute.

VISITORS

Visitors to the Snow Lab included the Region-Station Forest Service Advisory Committee, members of the Western Snow Conference, representatives of the Giannini Foundation for Agricultural Economics and engineers from the State Department of Water Resources.

The San Dimas Experimental Forest was visited by 364 persons during the 6-month period, including 44 foreign visitors and 124 students.

ROSTER OF TECHNICAL PERSONNEL

Division of Watershed Management Research
Pacific Southwest Forest and Range Experiment Station

Berkeley, California

Anderson, Henry W.
Andre', Johnnie E.
Court, Arnold
Gleason, Clark H.
Hopkins, Walt
Knoerr, Kenneth R.
Mansfield, Clifford W.
Miller, David H.
Rice, Raymond M.
Richards, Mrs. Lucille G.
Sinclair, J. D.

Glendora, California

Crouse, Robert P.
Krammes, Jay S.
Merriam, Robert A.
Patric, James H.
Rowe, Percy B.

Soda Springs, California

West, Allan J.

SEMIANNUAL REPORT - April 1, 1959 through September 30, 1959
Division of Watershed Management Research
Rocky Mountain Forest and Range Experiment Station

GENERAL

Judging from the volume of material which is to follow, our folks are obeying explicitly the WO's instructions to "let their hair down on a wide range of technical matters." At any rate, we have a lot of material to present and we think it is worthwhile.

Before launching into this, recognition should be given to two new watershed researchers who have joined our staff: Ron Tabler and Bob Swanson. Both have recently graduated from Colorado State University. Ron is working with Herb Berndt in Wyoming on a study of the hydrologic effects of sagebrush spraying. Bob is in Albuquerque working on an interesting new sap flow meter.

Sap Flow Meter

In July of this year, work was started on development of field equipment for measuring the velocity of sap flow by the heat transport method. In this method, a pulse of heat is inserted into a tree stem, and the temperature-rise-time curve is recorded at a given point downstream, usually ½ inch. The velocity of sap flow between the source of heat and the point of measurement can be determined by analysis of the derived curve. We hope that sap flow velocity can be used as a measure or index of the transpiration rate.

In the field equipment presently developed, the heat pulse is supplied by a 2 inch piece of nichrome wire enclosed in a hypodermic needle. A current of 18 amperes at 6 volts for 2 to 3 seconds supplies a temperature differential of about 2° F, ½ inch downstream. This temperature differential is detected using a small bead thermistor imbedded in the tip of a hypodermic needle. The thermistor forms one leg of a bridge which is balanced to zero at the ambient temperature of the tree. The out-of-balance voltage that results from the heat pulse is then amplified in a two transistor amplifier and read on a 100 microampere meter. Since the temperatures are used as ratios, there is no need to calibrate the meter in terms of degrees.

By using the temperature ratios at three given times, the sap velocity can be read directly from a three variable nomograph which has been prepared.

One drawback of this method is that it can be used only on trees with thermally homogenuous conducting tissue. According to Marshall (1958), this condition is met only in softwoods, and therefore this approach is not valid for trees other than conifers. For those wishing further information on the use and limitations of this method, reference is made to Marshall, D. C., "Measurement of Sap Flow... by Heat Transport," Plant Physiology, Nov. 1958, 33:6, 385-396.

Exploratory studies conducted to date indicate the field equipment presently developed is rugged and operable over a wide range of conditions. However, further investigations are needed before anything can be said concerning the reliability of the velocities obtained. Field studies to determine the reliability, ruggedness and the "best" sampling point within a tree, are being planned for the near future.

R. H. Swanson

Soil moisture under pinyon pine and blue grama grass

Winter-spring precipitation during 1957-58 at Pine Flat, in the Manzano mountains southeast of Albuquerque was sufficient to replenish ground water under both pinyon pine trees and blue grama grass cover. This condition is in marked contrast to the 4 previous over-winter periods when precipitation was inadequate to wet the soil to bedrock at the 30-inch depth.

By March 10, 1958 slightly less than 7 inches precipitation had fallen since November 1, 1957. On March 10, soil moisture had percolated below the 24-inch depth under blue grama grass and pinyon pine cover but had not yet reached the limestone bedrock at the 30-inch depth. Soil moisture was below wilting point at the 30-inch depth under both cover conditions at this time.

An additional .82 inch of precipitation fell evenly distributed in 2 storms on March 14 and 21. On March 21, soil water reached bedrock under both vegetation types. Only .45 inch precipitation fell between March 22 and 31 but both soil profiles remained wet from the surface to the bedrock. Another 2.83 inches of precipitation fell between April 2 and 17. The soil profiles remained wet during this period and an appreciable amount of the precipitation apparently entered the bedrock to recharge the ground water.

The latter half of April was dry and only .14 inch precipitation fell during the first half of May. Soil moisture depletion was rather small during April but the soil profiles began to dry out in May. Pine tree roots began extracting some moisture at bedrock in early May and the entire profile under pine was either at or approaching wilting point by June 10.

Under blue grama grass the entire soil profile remained wet until the middle of May when extraction of moisture from the upper layers began. Removal of soil moisture from the 30-inch depth did not start until after the middle of June although the upper 18 inches of soil was dry by this date.

During the 5 years of study, the maximum soil moisture conditions were reached during the winter-spring period. Summer rainfall although more plentiful was less effective because the hotter and drier weather and actively growing plants extracted soil moisture at a much faster rate. Almost a third, 32 percent of the annual precipitation, falls during the 2 hottest months of July and August when the evaporation-transpiration demand is greatest. Summer rainfall is insufficient to replenish soil moisture throughout the 30-inch soil profile. For example, in 1955, rainfall received in July and August amounted to 9.43 inches. On the basis of the adjacent Tijeras Ranger Station there was only one year out of 46 that exceeded the 1955 total for July and August and the excess amounted to only 3 percent. The relatively wet summer of 1955 resulted in penetration of moisture into the second foot of soil but failed to reach bedrock at 30 inches.

Although July and August rainfall is slightly more than that received in the 5-month period, November 1 to April 1, it is not nearly as effective in replenishing soil moisture. About 30 percent of the annual precipitation falls during the winter months of November through March, but most of this moisture comes as snow when vegetation is dormant and the evaporation-transpiration demand is low. Snow melts at a slow rate and very little melt runs off the soil surface when covered with pine-litter or dense blue grama sod, such as at Pine Flat. This period is the time when precipitation is most effective in replenishing soil moisture. Rain or snow received in early April when exceeding ½ inch also is quite effective in soil moisture accretion. Only 1 year out of 5 had sufficient winter-spring precipitation to yield percolation water into the limestone bedrock at 30 inches under pine-litter and blue grama cover.

During the first 3 years of study, maximum soil moisture penetration was reached during March but during the last 2 years the maximum soil moisture conditions were reached in April.

The first 3 years of study represented November 1 to April 1 precipitation conditions that can be expected to occur one-half of the time. However, April precipitation in these years was extremely low, equal or smaller amounts occurring only 15 percent of the time.

Since moisture penetrated to bedrock in only one winter-spring period out of five it is possible to predict the frequency of recurrence of this event on the basis of the long-term adjacent record at Tijeras Ranger Station. Apparently, about 7 inches precipitation falling between November 1 and April 1 is needed before soil water will reach bedrock at this site. If April receives more than 1 inch precipitation it appears that less than 7 inches but more than 5 inches precipitation must be received between November 1 and April 1.

On the basis of this study it is estimated that for similar vegetation soil conditions in the Manzano mountains, ground water recharge can be expected to occur somewhere between 20 and 25 percent of the time.

E. J. Dortignac

FLAGSTAFF

Moisture loss by the forest floor under pole-size ponderosa pine stands

Between 0.16 and 1.09 inches of moisture were evaporated from the forest floor on nine plots of pole-size ponderosa pine during 1 month of the summer rainy season. This represented a loss of from 7 to 27 percent of gross precipitation. The total moisture loss was directly and significantly related to the amount of gross precipitation falling on the plots during the study period and the weight of the forest floor found on the plots.

Table 1.--Forest floor moisture data for the period August 1 to August 30, 1957

Location	Total moisture loss	Forest floor	Gross ppt.	Max. moisture content computed for 1 day	Maximum moisture loss for 1 day	Storms over 0.01"	Total computed moisture loss as percent of gross precipitation
	Inches	Tons/A.	Inches	Inches	Inches	No.	Pct.
89A	0.162	3.7	2.48	0.047	0.035	15	6.5
Fort Valley	.228	4.9	1.85	.054	.038	13	12.3
Beaver Creek	.306	5.8	4.20	.084	.061	13	7.3
Fort Valley	.455	10.4	3.89	.163	.139	12	11.7
89A	.471	10.9	3.73	.167	.129	17	12.6
89A	.597	13.2	3.88	.216	.139	17	15.4
Fort Valley	.647	17.4	2.39	.182	.096	12	27.1
Beaver Creek	.796	18.4	4.43	.242	.129	13	18.0
Beaver Creek	1.087	21.1	6.45	.450	.292	15	16.9

E. F. Aldon

Water use for a 1-year period in the pinyon-juniper type on Beaver Creek.

Nine study plots were subdivided into three stand density classes, three plots per class. Average consumptive water use for each stand density class was obtained by the formula:

Use = Total Precipitation - Surface Runoff + Change in Soil Moisture

Class	Consumptive water use (inches)
Light	15.7
Medium	19.6
Heavy	18.7

Table 2 shows individual values. Interception is included in consumptive use, but was shown individually for interest.

It is apparent that differences in consumptive use are closely related to differences in change in soil moisture, which is largely a function of available water storage capacity.

C. M. Skau

Table2.--Water use in the pinyon-juniper type related to stand density

Plot	Avg. crown cover	Avg. no. trees/A. over 6 ft. tall	Avg. total precipitation	Average interception 1/		Average adjusted surface runoff 2/		Avg. soil moisture 4-58	Avg. soil moisture 4-59	Avg. soil moisture change	Avg. soil depth	Average available water storage capacity
	Pct.		In.	In.	Pct. of tot.ppt.	In.	% of tot. ppt.	In.	In.	In.	In.	In.
Light	17	45	14.95	1.20	8.0	0.37	2.5	3.63	2.50	-1.13	11	2.75
Medium	42	160	15.01	2.72	18.1	.22	1.5	16.64	11.78	-4.86	43	10.75
Dense	59	220	15.01	3.24	21.6	.09	.6	15.05	11.25	-3.80	39	9.75

1/ Stemflow was found to be a negligible amount.

2/ Surface runoff through three flumes adjacent to the plot area averaged a total of 0.22 inch during this period. This value was assigned to the medium stand density class, typical of the stand density on the experimental watersheds being measured for surface runoff. Surface water movement as measured by twelve 2 x 3 foot subplots in each stand density class had relative values of 1.5, 1, and 0.4 going from light to dense. The figure 0.22 inch was then multiplied by the appropriate relative value.

The weather above timberline in central Colorado

Weather data for the winters of 1958 and 1959 and the summer of 1958 have been analyzed. These records, taken in Loveland Basin at about 12,000 feet in the mountains west of Denver, show some interesting results.

Temperatures. A mid-winter warm spell was recorded both winters. This is the "January thaw" often mentioned by the old timers in the mountains. Daytime temperatures were above 32° F. for periods of 3 to 5 hours on each of 4 consecutive days in February 1958. Noon temperatures went to 38° or 39° F. on the 20th and 21st. The next winter, above freezing temperatures were recorded for 6 hours on January 12. Again the noon temperature went to 38° F. On January 4, 1959, just 8 days previous, early morning temperatures dropped to -19° F. This is the coldest temperature recorded at the station. It is interesting to note that there was a range of 57° F. in a period of just over 1 week. Contrary to popular belief, such temperature extremes are not common in the alpine.

Minimum temperatures for the winter months averaged between 3 and 12° F. while winter maximums averaged between 15 and 20° F. Temperatures dropped below -10° F. only four times during the two winters.

Summer temperatures averaged 45 to 50° F. with daily maximum temperatures averaging 53 to 59° F. and daily minimums averaging 29 to 36° F. Temperatures exceeded 65° F. only 3 days all summer and then just by one degree. Seven summer nights had temperatures at or below freezing. However, minimum temperatures averaged above freezing during June, July, August, and September. This means the late-lying snowfields are subject to melting temperatures both day and night for only this 4-month period.

Precipitation. Precipitation was measured with unshielded recording and standard gages. Since most of the precipitation fell as snow and was subject to considerable wind action at the exposed site, these records probably reflect less than the actual precipitation.

Annual precipitation for 1958 as measured in the standard precipitation gage was 18.47 inches. It is interesting to note that in a sheltered area, 1,000 feet below the alpine site, 16.17 inches of precipitation was measured for the period November 1958 to April 1959 alone. For this same period, the alpine gage showed 10.61 inches. Two factors contribute to this discrepancy: (1) not all the precipitation is caught at the windy alpine site; (2) some of the "precipitation" caught at the sheltered lower site is snow blown from higher elevations and not precipitation.

March and December were the wettest months at the alpine site with 2.79 and 2.58 inches respectively. Although the recording gage has proven unreliable during period of heavy snow, especially when strong winds accompany the snow, it appears that alpine storms seldom exceed 1 inch of water.

Records at the current station are too short to show year to year variation. However, summer precipitation records taken for the past 4 years at about the same elevation on Mt. Evans, 16 miles southeast, show quite a variation. During July and August of 1955, 12.00 inches of rain fell at this site while only 4.00 inches fell during the same period in 1958. It remains to be seen if such variations will appear at Loveland Basin or if they are characteristic of the more eastern location.

Precipitation during the period November through March totaled 8.4 inches both years. During the 1957-58 period, March had the heaviest precipitation. The next year heaviest snows were recorded in December with no sharp increase toward the end of the period.

Wind. Wind patterns are complex in the high mountain areas. A ridge west of the alpine research site offers protection from the direct onslaught of storm winds. It also channels the winds and increases turbulence. In the lee of this ridge, mean monthly wind velocities seldom exceed 10 m.p.h. From May until October 1958, monthly velocities were only about 5 m.p.h.

When the winds were analyzed on the basis of 6-hour periods, a more pronounced pattern appeared. The mean velocity for the windiest 6-hour period of each month was found to be from 2.0 to 3.3 (Ave. 2.7) times the mean monthly velocity. The maximum 6-hour velocity was 31 m.p.h. recorded on April 4, 1958. Only two other months (Dec. 1957 and 1958) had maximum 6-hour velocities as high as 30 m.p.h. During one 5-minute period on December 12, 1958, a sustained velocity of 60 m.p.h. was recorded. Undoubtedly velocities during the peak of gusts are still greater.

Periods of high winds in December and March or April of each year are thought to correspond to the movement of the polar front into and out of the area. At such times a thermal gradient would intensify the normal pressure gradient and cause the winds to be stronger than usual.

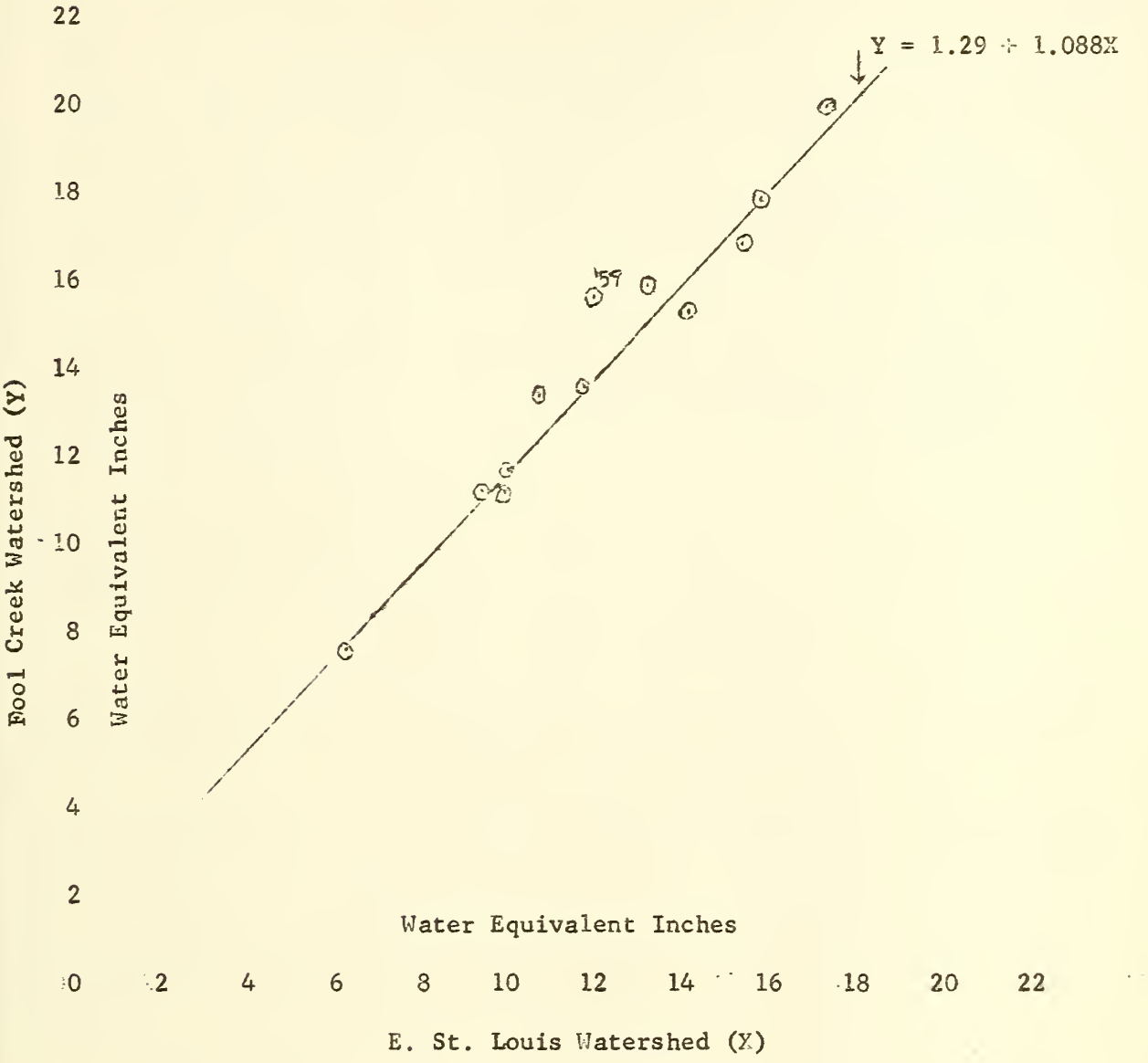
M. Martinelli

The effect of the Fool Creek cuttings on snow accumulation

Nineteen hundred and fifty-nine is the third year since 50 percent of the lodgepole, spruce-fir timber was harvested from 550 acres of the 714-acre Fool Creek watershed. A 100-stake, figure 8 pattern snow course has been measured annually at Fool Creek and a 63-stake course has been measured on the control watershed, E. St. Louis, during the period of 1943-1954, with the exception of the winter of 1945. A regression line for snow accumulation has been determined from the surveys of this pre-harvest period (Fig. 1). In 1959 the first post-harvest survey was made on these two watersheds. The value for this year reveals that the Fool Creek strip cuttings (of 1, 2, 3 and 6 chain widths alternating with equal widths of uncut strips each of which is approximately 600 feet in length) have had a positive effect on snow accumulation. Nearly 2 inches more water equivalent of snow was measured on Fool Creek in 1959 following the strip cuttings than would have been expected had there been no watershed treatment.

G. B. Lloyd

Figure 1.--Relation of April Snow Storage on Two Experimental Watersheds - Fraser Experimental Forest.



A review: Evaporation from snow and snowmelt by: Otto Kirschmer and Kazys Rimkus

The Obernach Experiment Station, Germany, carried out snow investivations in the winters of 1937-38 to 1944-45. The objective of the study was to gain fundamental knowledge about the evaporation from snow and about the connected problems of thawing and condensation. This knowledge should be helpful for the planning of a hydraulic power station in the Alpine Mountains.

The study area lies in the Alps at 2,690 feet above sea level. Precipitation averages 63 inches a year. Since approximately 16 inches falls as snow, conditions for snow research are favorable.

A special snow scale was designed. The 3-ton decimal scale was sunk into the ground so that the scale platform (8.2 ft. x 8.2 ft. = 67.2 sq. ft.) formed a line with the ground surface. The platform is insulated against temperatures from the basement below the scale and it is sloped towards the center to catch the melt water. A pipe runs from the center to a storage tank on the scale.

Before weighing took place the snow on the platform was severed from the surrounding snow cover by a vertical cut with a sword. To determine the evaporation from snow, data were collected only on days without precipitation.

The result, as reported by the investigators, is surprising. There is no evaporation from snow. The values for evaporation and for condensation obtained during seven winters are so small that they can be neglected for practical purposes.

Snow melted all winter long. The melting process took place right from the start also of unusual severe winters. But it was slower in winters with severe temperatures.

The continuous snow melting is explained by the fact that the soil temperature even in extremely severe winters never fell below 32° F. For example, during a prolonged period of frost, with air temperatures of -22° F. the soil temperature was 32.9° F.

This phenomenon results in the release of great portions of the snow water content during winter. Therefore, the authors conclude that high spring flows in mountain streams are highly independent of the snow volume that fell during the winter.

(This article was translated from German and reviewed by B. H. Heede).

Aspen uses more water and grows on wetter sites on Black Mesa than spruce or grassland.

Relative water use by aspen, spruce and grassland on Black Mesa in western Colorado has been studied for 3 years. Soil moisture was measured gravimetrically to a depth of 8 feet at the beginning and end of the growing season (about 114 days). The difference in moisture content plus summer precipitation was considered to be the amount of water used.

Statistical analyses show that the amount of water used was significantly different among each of the three vegetation types. Aspen withdrew soil moisture from the top 8' of soil at the average rate of 0.17"/day, while spruce withdrew 0.12"/day and grassland only 0.07"/day.

Figure 2 illustrates the total use differences for the three years of study.

The exact disposition of summer precipitation was not known, but because runoff did not occur as a result of summer rainstorms, the amount of precipitation that occurred between spring and fall was added to the amount of spring soil moisture. For simplicity, this was termed the amount of water available for plant use. Comparing this figure with the amount of soil moisture (to 8') remaining in the fall, showed aspen sites to be wetter than the spruce or grassland both spring and fall. Spruce and grassland sites had about the same amount of available water; however the spruce sites were drier than the grassland in the fall. (See figure 3.)

Figure 4 compares the amount of moisture withdrawn from the top 4 feet of soil with that withdrawn from the top 8 feet. While the difference in water use was highly significant among all three types for the 0-8' soil layer, the aspen and spruce used about the same amount of moisture from the 0-4' layer. Grassland used less water than spruce or aspen at both depths, in fact, practically no water was withdrawn below 4 feet by the grassland type.

J. R. Thompson

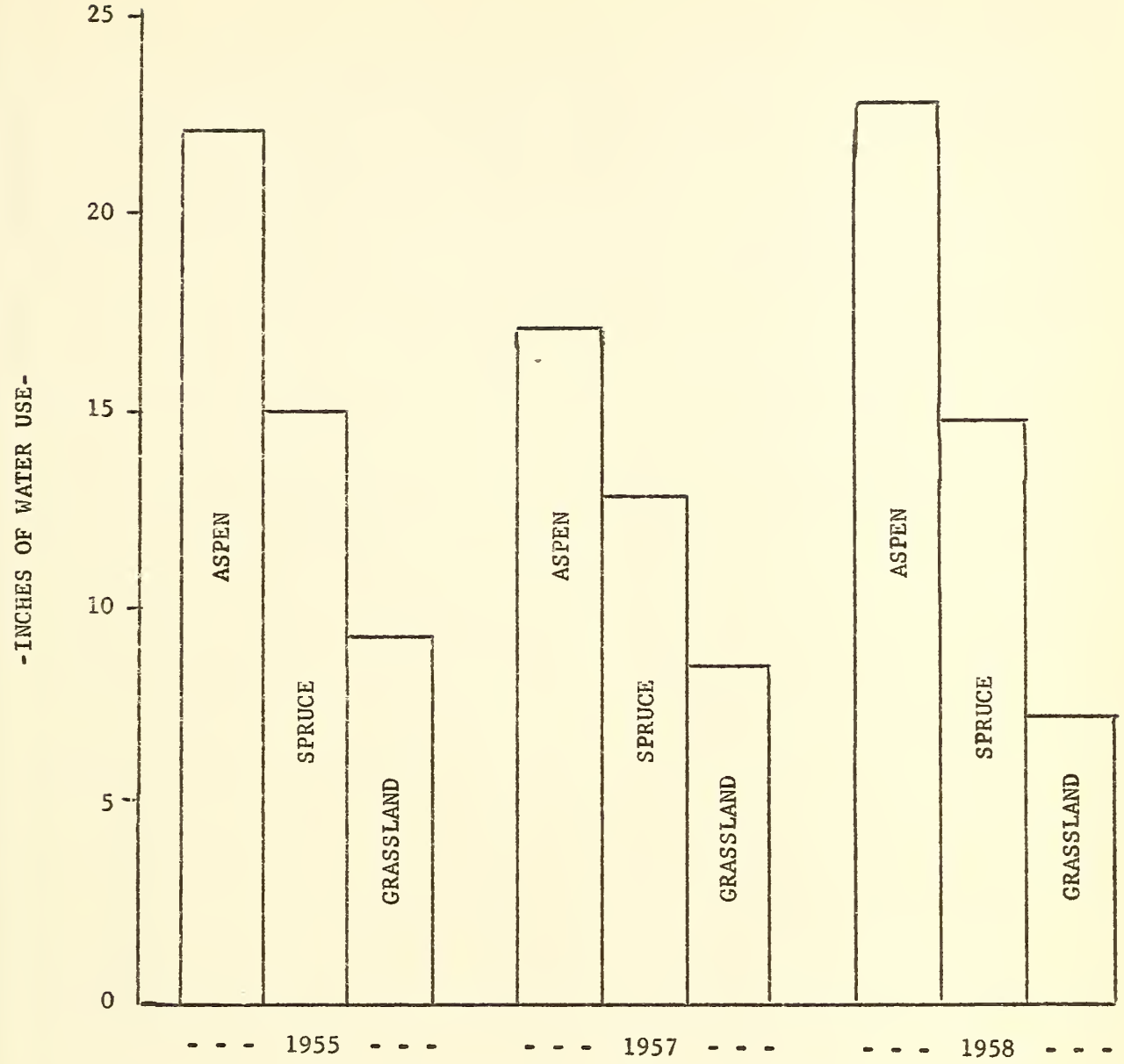


Figure 2.--Relative water use by aspen, spruce and grassland to depth of 8 feet on Black Mesa during summer growing season.

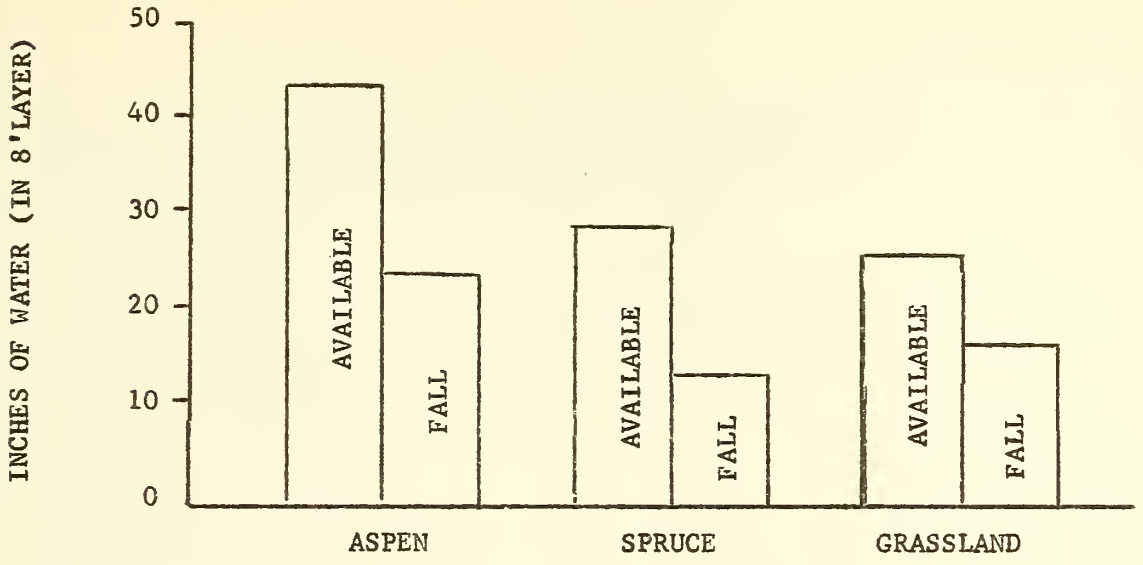


Figure 3.--Water available for plant use compared with moisture remaining in the fall (average for 3 years for depth of 8 feet).

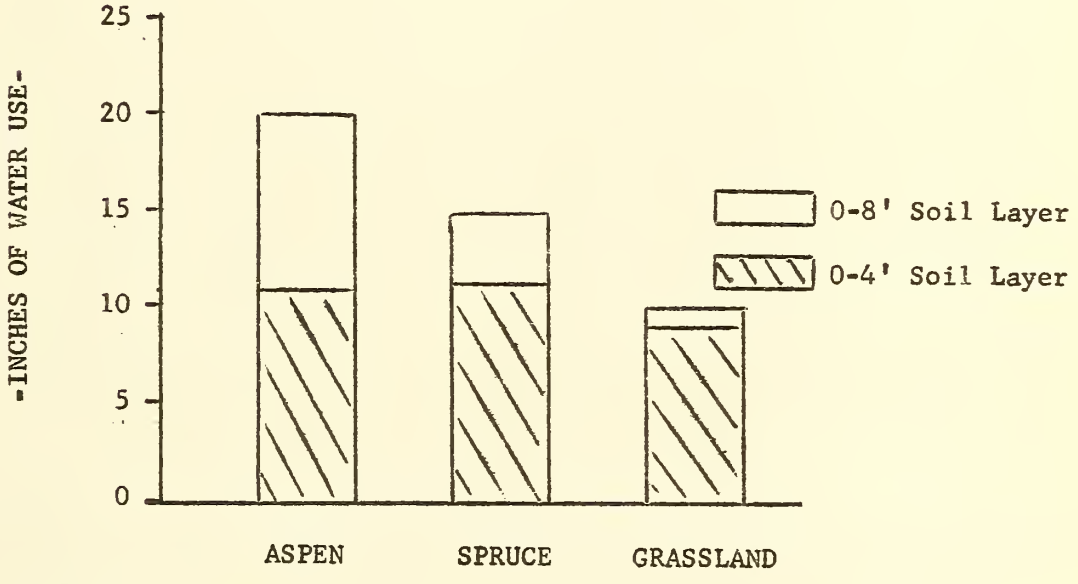


Figure 4.--Comparison of water use from 0-4' and 0-8' soil layers on Black Mesa (3 years of record).

In June Ron Tabler was added to the rolls. Ron, who hails from Denver, recently graduated from Colorado State University with a major in watershed management.

Opening of field season in late April found us divining our partially constructed gaging stations beneath 8 feet of snow in order to protect them from washout and to temporarily rig recorders. The operation was successful. After several false starts, the snow melted and runoff was recorded. The rest of the field season was devoted to completion of all installations and to routine data collection.

The gaging stations built for this study are conventional V-notch weirs (one 90° and two 120°) with capacity for a head of 30 inches. However, since they are built entirely of redwood, some of the construction details may be of interest to many. Cut-off walls are of 3" x 6" shiplap. Joints were glued with a resorcinol glue and nailed. Pond walls are of 2" x 6" stock spaced ½" apart. The still wells are set inside a 4' x 4' basin (which also serves as instrument shelter foundation) constructed from 2" x 6" stock and coated on the inside with foam plastic insulation board.

Some of the problems of this type of construction observed to date are:

1. The cut-off walls bowed visibly when a head of water built up. This resulted in leakage due to failure of several of the brittle glue joints. To remedy this situation we have braced the walls from the downstream side and have begun applying heavy coats of plastic roof cement to the upstream side. Perhaps a non-hardening calking compound would have made a better joint seal than resorcinol glue.

2. Backfilling weirs is not a new problem, but it was especially difficult here. Considerable shoring was needed to keep the pond walls in line during filling. We will be reluctant to remove the braces for sometime to come.

Despite difficulties encountered we still feel that redwood construction of stream gages is an expedient in remote areas. Comments from others who have had experience with such installations will be appreciated.

H. W. Berndt

Soil moisture under thinned and unthinned ponderosa pine

Moisture content of the upper 4½ feet of soil was less under unthinned than under thinned ponderosa pine both at the start and at the end of a 14-week period during the summer of 1958. The unthinned stand used 1.04 inches more total moisture during this period than the thinned stand. These results of soil moisture and precipitation measurements on thinned and unthinned plots of ponderosa pine and on adjacent clear-cut plots are summarized in Table 3.

Table 3.--Moisture content of the upper 4½ feet of soil and precipitation on a clear-cut plot and on thinned and unthinned ponderosa pine plots.

Item	Clearcut		Thinned		Unthinned	
	Date	Inches	Date	Inches	Date	Inches
Moisture content						
Start	6/17	18.50	6/19	17.89	6/20	14.92
End	9/24	17.83	9/24	12.79	9/25	8.60
Reduction	--	0.67	--	5.10	--	6.32
Gross precipitation	--	7.02	--	6.90	--	6.72
Seepage	--	?	--	0	--	0
Evapo-transpiration	--	?	--	12.00	--	13.04

The thinned plot has 435 trees per acre averaging 5.8 inches d.b.h. There are 2,885 trees per acre on the unthinned plot averaging 3.3 inches d.b.h. Basal area is about 80 square feet per acre on the thinned plot as compared to 171 square feet per acre on the unthinned plot. Both stands are 65-70 years old.

The upper 4½ feet of soil in the study area holds 19.38 inches of water at storage capacity. Moisture content at wilting point is 9.79 inches of water. Thus 9.59 inches of water are available for plant growth when the soil is at storage capacity, or 2.13 inches of water per foot of soil.

On the starting date there were 8.71 inches available water on the clear-cut area, 8.10 inches on the thinned plots, and 5.13 inches on the unthinned plots. Fourteen weeks later there was still 8.04 inches available water on the clear-cut plot, 3.00 inches under the thinned stand, but none under the unthinned stand.

Moisture was lost from the clear-cut plot only by evaporation and only from about the upper 18 inches of soil. This plot may have contributed some seepage to ground water. There was some moisture depletion throughout the profile on the thinned area, but no part of the profile was reduced to wilting point except perhaps the surface few inches. The unthinned stand apparently drew all available moisture from the entire soil profile.

Surface runoff from grazed Kentucky bluegrass range

Surface runoff was 0.72 inch from a 16 x 16 foot runoff plot on grazed Kentucky bluegrass range between July 1, 1958, and June 30, 1959. This is 3.7 percent of the 19.28 inches of precipitation that fell during the year.

A total of 0.27 inch of runoff came during one high intensity rainstorm of 0.65 inch on September 10, 1958. Melting snow on frozen ground produced 0.38 inch of runoff between March 9 and 24. These two amounts together made up 90 percent of total runoff for the year.

This runoff plot is located in a bluegrass streambottom in the central Black Hills. Such streambottoms are typically narrow and bordered by steep timber-covered slopes. The combination of desirable forage and accessibility makes them natural concentration areas for cattle.

Two 4 x 10.9 foot (1 milacre) plots were installed in the same vicinity on April 28, 1959. Total precipitation depth to September 8 was 9.37 inches. Runoff totalled 0.24 inch from the 16 x 16 foot plot and 0.25 and 0.26 inch from the mil-acre plots--averaging 2.7 percent of total precipitation. Most of the runoff came from one high intensity rainstorm on July 15. Total storm depth was 0.79 inch. An actual 0.45 inch fell in 5 minutes. Runoff was 0.21 inch from the 16 x 16 foot plot and 0.21 and 0.19 inch from the mil-acre plots.

So far the one mil-acre plots have yielded about the same amounts of runoff as the 16 x 16 foot plot. Frames for the smaller plots are less expensive and easier to install and operate.

Precipitation-streamflow relationship in the Rapid Creek watershed of the Black Hills

Annual runoff increases an average of 0.204 area inch for every one-inch increase in annual precipitation on the Rapid Creek watershed in the Black Hills. This holds true for the measured range of annual precipitation from 11.76 to 34.80 inches between 1915 and 1942. The relationship is linear and is defined by the following equation:

$$Y = 0.2042X_1 - 1.0831 \quad \text{where}$$

Y = estimated runoff in inches

X_1 = annual precipitation in inches.

The amount of runoff yield in a calendar year also increases with increase in the amount of precipitation in the preceding September-December period. With this factor included the relationship becomes:

$$Y = 0.2042X_1 + 0.5545X_2 - 3.3360$$ where

Y = estimated runoff in inches

X_1 = annual precipitation in inches

X_2 = antecedent September-December precipitation in inches.

The two precipitation factors together account for 70 percent of the variation in annual runoff.

H. K. Orr

TEMPE

Phreatophyte Project

Seed germination (Loss with time)

Germination tests of seed of five-stamen tamarisk (Tamarix pentandra), seepwillow (Baccharis glutinosa), broom baccharis (Baccharis sarothroides), arrowweed (Pluchea sericea), and Fremont cottonwood (Populus fremontii), have been made during the past 2 years. All tests were made by spreading seed on moist filter paper in closed Petri dishes. Except for special tests of the effect of temperature upon seed viability, seed was stored in the laboratory with temperatures varying between 72° F and 80° F.

Tamarisk: Tamarisk seeds collected in the Spring of 1957 and 1958 lost nearly all viability by the following winter, except for an occasional seed. Thus seeds produced in the spring do not carry over to germinate the following spring.

Seeds ripening in the summer (August-September) of 1957 maintained some viability for nearly a year, though 75% of the seeds gave no germination after 12 weeks. Thus summer seeds may carry over and germinate in the next growing season.

The contrast to the 1957 summer seed, those collected from August to September 1958 followed more nearly the pattern of spring seed. However, some vitality was retained even six months after collection.

Other species: Seepwillow seed gave a lower initial germination than tamarisk seed, but germinating capacity was retained for a long period. Spring seeds have a higher germination rate than fall seeds. Broom baccharis seeds collected in November 1957 had a viability of 90 percent after 18 months of storage. Fremont cottonwood seed lost all

viability by the seventh week after collection. Some lots of arrowweed seed gave high germination percentages. Others averaged 10 percent or lower. A fairly constant germination seems to be retained for at least a full year.

Effect of temperature on germination

High temperatures, comparable to those in the field, were found to reduce viability of tamarisk seed. A portion of each of 15 lots collected in the spring and summer of 1958 were stored in a well-ventilated greenhouse where temperatures were approximately the same as outside. Greenhouse-stored seed deteriorated about twice as fast as laboratory-stored seed. Contrawise, seed of both tamarisk and seepwillow retain viability for periods well over a year when stored at 40° F.

Seedling establishment under variable flow

Tamarisk and seepwillow seeds germinate in wet soils or on water surfaces. Receding flood flows provide excellent conditions for seedling establishment. A side channel of the Salt River has been observed closely since January 1957. At the beginning of February, 1957, the entire channel area from near high-water mark down to low water was covered with abundant tamarisk and a few seepwillow seedlings which had become established in the fall of 1956.

During the first part of March the flow in the Salt River increased and removed all the seedlings that were submerged. As the water receded only seepwillow seedlings became established because tamarisk seeds had not yet ripened.

High water in early April again removed many seedlings leaving an upper bank of mixed fall-established seedlings and a lower band of seepwillow. During the receding flow of April from 20 to 100 tamarisk seedlings per square foot became established. A slight rise in river flow in early May removed some seedlings but a new crop developed as this flow receded.

In the first weeks of June a major flow removed all seedlings. Except for a recession in the middle of June, high flow kept all seedlings from developing in the study area.

Apparently, seedlings become permanently established only after high flows which not only recede during periods of abundant seed, but also are not followed by subsequent flows of equal height.

Salt accumulation by tamarisk and associated species

In quiet air tiny columns of salt form on both the upper and lower surfaces of tamarix leaves. These columns are long, delicate, and thread-like, from about 0.01 mm. to 0.05 mm. in diameter and up to 1.0 mm. long. They are usually contorted, with irregular surface and diameter. They

appear to be tightly packed columns of extremely fine crystals. Columns deliquesce during exposure to high humidity and form tiny spherical droplets. Many of these coalesce upon standing and form larger glittering spherical droplets--making the tamarisk look like a miniature and heavily decorated Christmas tree. Hairs do not reform when droplets dry; the salt now appears as large and small cubical crystals. This shape is characteristic of NaCl.

The hair-like columns of salt originate from definite glands that are distinctly different from the far more abundant stomata.

J. S. Horton

Measuring evapotranspiration of different species and associations using the infrared gas analyzer

New tents for the evapotranspiration apparatus have been made and tested. They are octagonal in plan and made of 1-mil (0.001") Mylar (Dupont trade name) polyester film. Mylar is much stronger and more stable photochemically than polyethylene, but is somewhat brittle and crinkly.

New and more consistent spray-jet calibrations of the apparatus have been made. Agreement between actual rate of vapor generation and estimated rates based on hygrometry has been good at higher humidities--above 10 mg./liter (about 30% RH at 86° F.). At low humidity, below 15% RH at 86° F., estimates based on the infrared hygrometer ran about 150% of actual rates.

Calibration of the infrared hygrometer (water vapor analyzer) based on constant-humidity standards (distilled water, and saturated salt solutions held at constant temperature in bubbler-bottles) was rechecked in the laboratory against a system where weighed amounts of water vapor were generated in measured volumes of dried air. The two systems were found to agree closely.

J. P. Decker

Chaparral Project

3-Bar Watersheds

A single 8.61 inch January storm produced 40 percent of the total runoff for the 1956-57 water year on the 3-Bar watersheds in central Arizona. Heavy runoff following this storm brought only a trace of sediment to the weir basins.

Eighty-six percent of the total precipitation fell between October 1 and May 31--the period most favorable to water yield. Such a high percentage of winter moisture is rather unusual, however, in central Arizona. Runoff from watersheds "C" and "D" was confined to the winter

and spring periods, January to early June. Recovery of total precipitation ranged from 0 on watersheds "A" and "B" to 9.1 percent on watershed "D" (Table 4).

Table 4.--3-Bar Cooperative Watershed-Game Study. 1956-57 Water Year.

Watershed	Total ppt. (in.)	Oct.1 - May 31 ppt.	Runoff (in.)	Runoff as % of total ppt.
A	22.95	19.63	tr.	0
B 1/	25.14	21.67	0	0
C	25.14	21.67	1.77	7.0
D	25.95	22.02	2.35	9.1

1/ Record taken from gage at adjacent Watershed "C".

P. A. Ingebo

Controlled burning of chaparral during non-critical periods

Following three different intensities of "smashing" during May 1958, mixed shrub live oak-skunkbush-ceanothus brush on 4.8 acre plots near Prescott, Arizona, would not carry fire when ignited by simulated area ignition technique. Tests were conducted on October 16, 1958, and April 8, 1959. In each case individual smashed and partly smashed bushes burned when ignited, but fire would not carry to adjacent bushes.

Conditions existing on the plots at time of burning are shown below:

Block No.	Date Burned	Air Temp. (°F)	Rel. Humid. (%)	Wind (mph)	Moisture Content Leaves S 1/	Leaves U 2/	Twigs S	Twigs U	Litter U
IV	Oct.	73	29	0-7	8.1	84.4	10.5	71.4	8.5
III	Apr.	61	45	5-20	-	78.4	11.3	77.4	12.8

1/ From smashed plants

2/ From unsmashed plants

Data from bi-weekly sampling shows that smashing reduced moisture content of small twigs from more than 70 percent on untreated to about 10 percent on treated stems (dry wt. basis). Leaf moisture content was reduced from about 80 to less than 10 percent 2 months after smashing; but dried leaves fall from stems 3 to 4 months after smashing. In recent preliminary tests by ARS, application of both 2 and 4 lbs/acre of 2,4-D and Silvex in 10 gallon diesel fuel gave leaf moisture reduction to 11 percent after 2 months, as compared with 85 percent on untreated plants. No reduction in twig moisture was found after 2 months; but some death and drying may occur later.

Inadequate fuel, associated with sparse shrub cover (34.0 and 35.7 percent on Blocks III and IV respectively) is suspected as major cause of poor burning and will be further investigated in subsequent tests. Sampling by the "weight estimate" method just prior to the April tests showed a gross average fuel weight (uncorrected for moisture) of 5.3 tons per acre, with a maximum indicated weight of just over 20 tons per acre on a single 100 square foot sample plot. Distribution of fuel among sixty 100 square foot sample plots was as follows: 0-3 tons per acre, 26 plots; 3-7 tons, 16 plots; 7-15 tons, 15 plots; and over 15 tons, 3 plots. This skewed distribution of fuel may be characteristic of low to moderate density chaparral stands.

Analysis of vegetation sampling data shows that fuel weight, as estimated, was correlated with volume (shrub crown area x mean height), r=0.668, thus suggesting a possible sampling method for both plant cover and weight.

G. E. Glendening

Mixed Conifer Project

Sediment production in the ponderosa pine type

During the spring runoff of 1958, the weir pond at East Fork of Castle Creek Experimental Watershed trapped nearly 44 cu. yds. of sediment, mostly coarse grained sand. This 1000 acre watershed is not dissected by channels and the watershed area does not show extensive erosion. The stream channel, however, is similar to most channels in the pine-fir area of Arizona, in that it flows through flat meadows and wide-bottomed forest areas. Many of these channels are paved with coarse sediments. High water gradually moves these sediments downstream.

Reconnaissance survey of the distribution and disposition of snow

Areal coverage of snow was mapped during the spring of 1959 to relate peak discharges to snow disappearance on selected areas of the Apache National Forest. Snow cover was below average for surrounding snow courses. Spring runoff peaks were almost non-existent on major streams in Arizona, and were below storm peaks for the rains of the preceding fall. In general snowmelt peak occurred between the 7th and 11th of April.

East Fork of Willow Creek. A comparison of runoff with the disappearance of snow on the Willow Creek Watershed suggests the seasonal contribution that snow makes in water yield. Figure 5 shows three major peaks in runoff. The peak in September and October corresponds with rainfall during the same months. Similarly, peak runoff in November and December can be accounted for by the large storm in November.

Storms in January and February occurred as snow and peak discharge from this precipitation did not take place until April.

Table 5 shows the relative order of disappearance of snow with regard to aspect. In general, snow began to melt first on south and east aspects. Last disappearance was on North and Northwest aspects. In comparing snow cover with the spring peak discharge in Figure 5, it appears that snow melt from the cool slopes, north, east, and west, contributed most to peak discharge. The snow from south slopes was essentially gone before peak discharges.

Table 6 gives an indication of the relation of temperatures to peak discharge. During the period April 3 through April 11, both maximum and minimum temperatures increased slightly. Snow melt was rapid on north slopes during this period and coincided with the time of peak discharge.

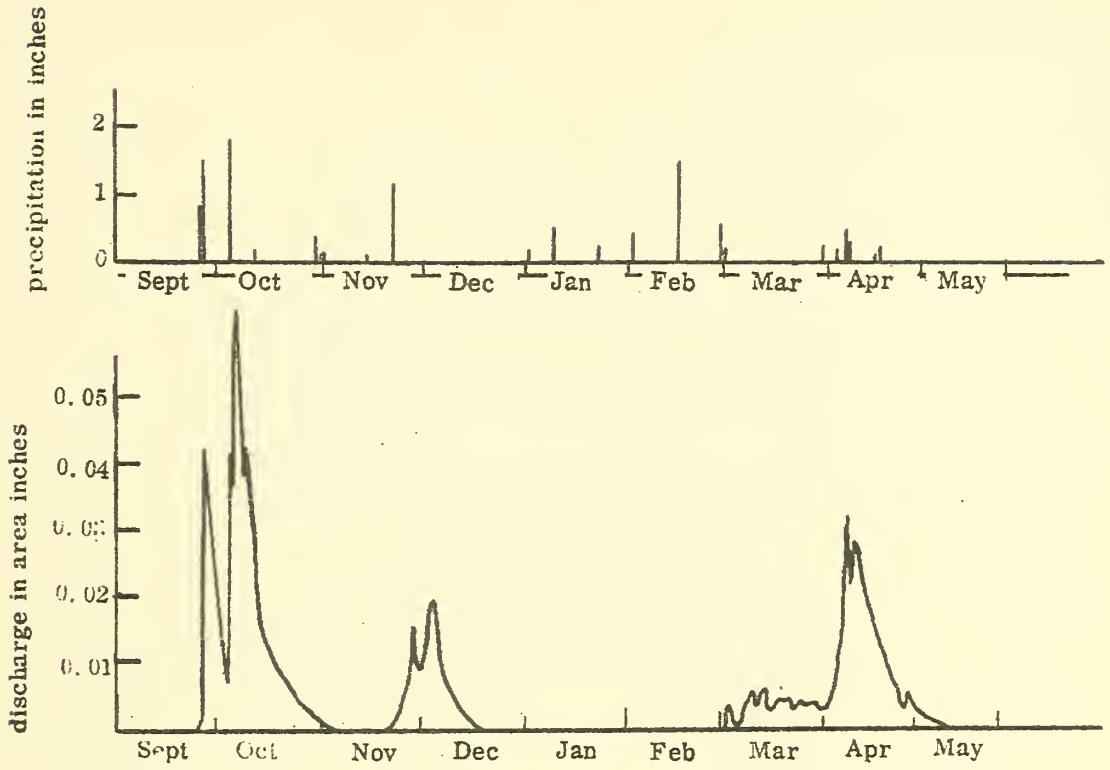


Figure 5.--Comparisons of peak discharges with periods of precipitation, for the East Fork of the Willow Creek Watersheds in 1958-59. The peak in September and October corresponds with rainfall during the same months. The flow of November and December resulted from the large storm in November. Snow accumulation in January and February was discharged by melting in April.

Table 5.--Percent snow cover on East Fork Willow Creek Watershed during snow melt, March 20-April 22, 1959.

Slope & Location	Date of Mapping 3/20/59	4/1/59	4/15/59	4/22/59
	(Percent of area covered with snow.)			
Northwest slope above weir	100	90	60	0
Northwest slope near weir	100	100	60	30
Northwest slope middle of watershed	90	45	3	0
North slope	95	80	25	3
Southeast slope near weir	20	0	0	0
East slopes near weir	30	30	7	0
East slopes middle of watershed	50	40	7	0
East slopes upper part of watershed	50	30	7	0
North slopes near stream channel	50	30	10	5
South slopes	10	0	0	0
Temperature for week preceding: Mean Max.	52	52	55	55
(in degrees Fahrenheit) Mean Min.	20	25	24	27

Table 6.--Snow cover, depth of snow, and water content compared with temperatures for a meadow near the middle of the East Fork of Willow Creek Watershed.

Date of mapping	Temperature for week preceding (degress Fahrenheit) Mean max.	Mean min.	Percent of snow cover South slope	North slope	Meadow	Snow in meadow Depth of snow (inches)	Average water content (inches)
3/13/59	53	17	5	100	100	18	5½
3/20/59	52	20	2	100	90	11	5
3/27/59	48	20	0	100	80	7	3
4/3/59	59	29	0	75	0	0	0
4/11/59	59	28	0	30	0	0	0
4/17/59	55	26	0	15	0	0	0
4/24/59	57	26	0	3	0	0	0

Greens Peak mapping

Percentage of snow cover as mapped from Greens Peak are shown in Table 7.

Table 7.--Percent of snow cover by types as mapped from Greens Peak.

Date of mapping	(Percent of snow cover) (1) Flat grassland	(3) North facing conifer timber	(8) South facing conifer timber	(10) North facing aspen	(14) South facing aspen	Temperature for week preceding Mean Max. of	Min. of
3/12/59	90	100	75	100	75	51	14
3/19/59	65	100	50	100	75	53	19
3/31/59	10	100	40	80	25	51	23
4/14/59	5	85	0	10	25	54	24
4/22/59	0	75	0	0	0	55	27

Only small discharge peaks occurred on Salt River. The high peak for the spring, 350 second ft., was on April 11, 1959 and seems to be related to the start of snow disappearance from north facing conifer timber areas and general disappearance of snow from other timber areas.

L. R. Rich

Consumptive use of spruce-fir, aspen, and grassland as measured by soil moisture

Gravimetric samples of soil moisture have been obtained for three sampling periods at eight depths under grassland, aspen, and spruce-fir types (Table 8).

Soil moisture in the study area was very favorable in the fall of 1958 as a result of late summer rains. Although the winter precipitation was much below normal, the early spring sampling showed good soil-moisture storage and indicated some accretion during the winter period under grassland and aspen types. Spruce-fir indicated some winter depletion.

Grassland cover indicated very little soil-moisture use during the latter part of April and most of May. Aspen showed moisture decline in the surface two feet of the profile. Spruce-fir lost moisture from the surface three feet of the profile during the same period.

Access tubes for the measurement of soil moisture by the neutron method were installed during the last week of May. By the new method much better moisture determinations are anticipated; because of the boulders within the sampling zone, gravimetric sampling was both costly and subject to considerable variability.

Table 8.--Soil moisture percentages based on oven-dry soil for three cover types and three sampling periods for eight depths.

Sampling Period	Cover Types		
	Grassland	Aspen	Spruce-fir
	(percent Soil Moisture)		
		0-1 Ft.	
Oct. 6-10, 1958	33.1	32.0	40.4
April 16-22, 1959	33.8	39.8	52.1
May 26-31, 1959	21.1	22.5	19.7
		1-2 Ft.	
Oct. 6-10, 1958	26.4	28.6	29.5
April 16-22, 1959	27.9	35.3	22.5
May 26-31, 1959	27.5	28.1	19.7
		2-3 Ft.	
Oct. 6-10, 1958	26.2	31.8	28.1
April 16-22, 1959	33.7	37.4	33.2
May 26-31, 1959	34.6	35.2	26.9
		3-4 Ft.	
Oct. 6-10, 1958	29.4	36.0	37.0
April 16-22, 1959	33.6	42.6	25.9
May 26-31, 1959	41.3	43.6	32.2
		4-5 Ft.	
Oct. 6-10, 1958	34.3	42.6	40.1
April 16-22, 1959	47.6	48.7	32.9
May 26-31, 1959	50.6	48.7	34.2
		5-6 Ft.	
Oct. 6-10, 1958	44.5	45.5	42.6
April 16-22, 1959	48.5	47.9	36.3
May 26-31, 1959	55.3	53.2	33.0
		6-7 Ft.	
Oct. 6-10, 1958	51.0	47.7	43.4
April 16-22, 1959	53.6	46.4	37.4
May 26-31, 1959	58.9	50.4	37.2
		7-8 Ft.	
Oct. 6-10, 1958	41.8	50.3	43.7
April 16-22, 1959	56.6	40.1	44.7
May 26-31, 1959	56.0	52.3	39.9

P. T. Koshi

SEMIANNUAL REPORT

Division of Watershed Management Research
Southeastern Forest Experiment Station

April 1, 1959 - September 30, 1959

COWEETA HYDROLOGIC LABORATORY

(Prepared by A. R. Hibbert)

Cooperative Studies

A cooperative study by the Soil Conservation Service and Forest Service to determine rainfall-runoff relations for varying soil moisture conditions and the general application of SCS methods of hydrograph analysis to small mountain watersheds in the Southern Appalachians was conducted at Coweeta during the summer by E. H. Hejl, assisted by Paul Britt, both of SCS. Results indicate that much remains to be learned about small watershed hydrology. Methods that generally apply to large drainage areas failed to give consistent results when applied to small mountain watersheds at Coweeta.

Water Yield Studies (FS-1-w7-6-SE)

The repeated annual releasing of white pine seedlings on watersheds 17 and 1 has heretofore been accomplished by mechanical cutting of the hardwood sprouts, blackberry, and grapevines during the dormant season. The desired effect of the release cuttings has been lessened considerably by prolific regrowth of the sprouts and vines during the growing season, far overtopping the pines by early summer. Release cuttings during the growing season when most needed are impractical because the dense growth obscures the pines, making it almost impossible for the axman to keep from cutting the pines along with other vegetation.

During the summer of 1958 tests were made on the lower portion of watershed 17 to determine the type and concentration of chemical herbicides that could be used to control the sprouts and vines but not permanently injure the white pine seedlings. One quart of concentrate (4 lbs. per gallon) 2,4,5-T to 40 gallons of water appeared to give the best results. This concentration, applied by means of back-pack pumps during the summer of 1959 on watersheds 17 and 1, appears to have done an excellent job of control of the troublesome species with little if any retarding effect on the pines.

All but 5 acres of watershed 6 have been converted to grass. The first portion, about 9 acres, was planted to fescue grass (Kentucky 31) in March and an excellent stand was obtained. The second block of about 8 acres was planted during July and, although the south slopes were slow in coming through, a good stand has been established on it. The 5 remaining acres have been cleared of timber and will be made ready for planting early next spring.

A problem faces us now in maintaining the grass cover on watershed 6 so that water yields of a grassed watershed can be compared with yields from a forest cover and various other treatments. At this stage it is planned to use herbicides and possibly light burning in future control of sprouts and invading species. Herbicides were used during the summer and fall of 1959 to control root sprouting of the hardwoods and laurel which had been cut from the area. Laurel regrowth, which is generally very difficult to kill, was nicely controlled with a 2,4,5-T concentration of 2-ounce solution per gallon of water. The conversion operation from forest to grass is in no way designed to be a practical method of improved pasture establishment. The clearing of the forest cover and preparation of a seedbed were both very laborious and costly operations; the soil is very acid, requiring 3 tons of lime per acre plus a ton of 5-10-10 fertilizer per acre with subsequent top dressings after establishment because of nitrogen deficiencies. The cost of conversion is estimated as upwards of 500 dollars per acre.

Soil Moisture-Base flow Relations (FS-1-w1-6-SE)

A new exploratory study to throw light on the source of base flows of small mountain streams in the Southern Appalachians was begun at Coweeta during the past summer. The generally accepted sources of water that feed seeps and springs of a permanent nature are considered to be the rather extensive sloping ground water tables or aquifers adjacent to the spring head. This theory may not be adequate to describe the phenomena that exists at Coweeta. It is not uncommon to find a permanent spring within 200 feet of the uppermost boundary of a watershed and on a slope of 50 to 80 percent or more. The characteristic soil of such an area averages about 4 feet deep over impermeable schists and gneisses which show little indication of fracture and faulting. Under such conditions it is difficult to visualize a water table of any consequence and especially one that could feed a spring throughout a protracted period of 2 or more months of drought which has been observed at Coweeta with no failure of spring flow.

To seek some preliminary answers to this problem a soil model was constructed on a 40 percent slope. A box 24" wide by 18" deep by 32' long was packed with soil to approximate field conditions. An artificial water table was established at the base to overcome the air-water interface that might impede drainage. The model was saturated with water and allowed to drain for a period of 10 days throughout which time water continued to flow from the model. A leak developed at the base of the model which made it impossible to measure the discharge as was originally planned. However, soil moisture depletion was followed throughout the 10-day period by the neutron scattering method by means of access tubes at 4-foot intervals through the soil model. A soil moisture gradient decreasing with elevation was soon established after draining began. The difference in moisture content by volume between the bottom and the top was about 4 percent at the end of the period. After 10 days of draining had elapsed samples were collected by a Lutz sampler at 4-foot intervals along the model and subjected to 60 cm. of tension on a tension table. Samples taken from the upper end of the model took up water under 60 cm. tension while samples taken from the lower end released water under 60 cm. tension. This indicated a tension gradient running upslope with higher tensions at the top than at the bottom.

These results were further strengthened by a second packing of the model with soil and allowing it to drain after wetting. To date it has been 60 days since wetting, and although active drainage is now only periodic, water is still being discharged and measured with an automatic recorder. It has been found that temperature has a very marked effect upon drainage. Drainage ceases at night when the model cools and does not begin flowing again until the next afternoon when the model warms up. Further details and information on this project should soon be forthcoming since John Hewlett is preparing a report of results.

Personnel

In June, Research Center Leader, Don Whelan, was transferred to the U. S. Study Commission in Atlanta, Georgia. Alden R. Hibbert returned in August from Utah State University where he completed graduate work for a Master's degree. His thesis on small mountain watershed hydrology is nearing completion at Coweeta. John Hewlett, Acting Research Center Leader, returned to Duke University in September after spending the summer at Coweeta. His Ph.D residence requirements will be finished by June, 1960 after which he plans to complete his thesis problem in plant physiology at Coweeta. Lloyd Swift has completed his thesis problem on the effects of slope and aspect on solar radiation.

Meetings

On April 9 and 10, Swift attended the Eighth Annual Forestry Symposium at Baton Rouge, La.

Visitors

Coweeta was host to 347 visitors during the past six months. This included 74 from Federal agencies, 36 from State agencies, 159 university students and professors, and 78 from foreign countries.

UNION RESEARCH CENTER

(Prepared by James Douglass)

Measuring Soil Moisture (FS-1-w1-6-SE)

Prior to the advent of the neutron scattering method of measuring soil moisture, the resistance and gravimetric methods have been widely used; but the large amount of time involved in calibrating or sampling by these methods generally result in single plot studies for a given soil-cover complex. As such, these studies are worthwhile as indicators of relationship but their value in future research is limited.

Much time has been devoted in recent years to the theory, development, and testing of the neutron method of measuring soil moisture. Instrument development has progressed to a stage where the method now has promise for plant-soil-moisture investigations. Although many of the theoretical and instrumentation problems have been surmounted, the problem of field plot design requirements in using the method has received little attention.

A current study at Union concerned with a uniformity test of variance of soil moisture should supply guides for designing future field plot studies in which treatment effects can be evaluated statistically.

The study was set up in a 17-year-old loblolly pine plantation which appeared to have one soil type, aspect and slope. Analysis of moisture data has showed a significant difference in moisture levels between the two blocks. On one specific sampling date, a mean difference of 0.45-inch of moisture in 12 inches of soil was found to be significant. This difference which probably results from variations in soil texture, demonstrates the sensitivity of the instrument.

More important is the ability to show differences in water use by cover types. Here the neutron method enjoys a big advantage over the gravimetric method because the identical soil mass is remeasured on successive dates. By analyzing data in the form of moisture losses or gains from one date to another (differences in moisture) covariance, which exists when the same soil mass is remeasured, increases precision. As an example, analysis of moisture loss under the pine plantation shows that two of the plots are losing moisture more rapidly than are 4 other plots. Variations in rooting or texture may account for these differences. Since the instrument has measured real variations in water loss under apparently homogeneous soil, physiographic and cover conditions, the chances are good that if cover types vary in rates of water use, these differences can also be detected.

Analysis of data is not complete at present. The precision of the method as it is being utilized in the current plot-block design is encouraging. This, coupled with the knowledge that altering the design without increasing the number of access tubes will increase precision, indicates that the method will play an increasingly important role in future plant-soil-moisture research.

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SOUTHERN FOREST EXPERIMENT STATION
Watershed Management Research Semiannual Report

April - September, 1959

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Harrison Research Center

Litter-Humus Changes

Drastic litter-humus changes occurred in one year after hardwoods were killed in the Arkansas Ozarks.

Initial litter-humus samples were collected in February 1958 just after the following treatments were imposed on three identical areas: (1) An ungrazed, unsprayed woodland, (2) an aerially sprayed (2,4,5-T) woodland to be grazed from May 15 to July 15, and (3) an aerially sprayed (2,4,5-T) woodland to be grazed from May 15 to September 30.

Analysis of samples gathered in February 1959 showed the following changes:

Total oven-dry litter-humus weight on the ungrazed woodland rose to 9,569 pounds per acre from the 1958 weight of 7,147 pounds per acre. Litter-humus weights on the two sprayed areas decreased from 7,494 to 7,802 pounds per acre in 1958 to 4,433 and 4,043 pounds per acre, respectively, in 1959.

Retention water storage of the litter-humus was 0.11 and 0.08 inch of water per surface acre in 1958 but only 0.035 and 0.036 inch in 1959. Total storage loss amounted to one-acre foot of water for each 267 to 160 acres of soil, respectively. The forested area litter-humus increased its retention storage capacity during the same period from 0.10 to 0.107 inch.

In 1958 a 12-day period was required to air-dry litter-humus samples under controlled laboratory conditions. In 1959 samples from the unsprayed area required 13 days to reach air-dryness. The sprayed area samples reached this point in nine days. These samples lost 90 percent of their moisture within a three-day period in 1959.

In 1958 they required seven days. The forested area samples required seven days in 1958 and nine days in 1959 to lose 90 percent of their moisture.

Erosion Depth Gauge

An erosion depth gauge sensitive to 0.01 inch was developed to measure erosion in north Arkansas. The new gauge is accurate and simple to use. Measurements can be duplicated by different operators. A two-man team requires a five-minute period for setting the gauge up, measuring and recording the data. The unit consists of a "T" frame with three legs. Each leg may be adjusted to level the instrument. The top bar of the "T" is set up to reference points on two steel stakes located 24 inches apart. The top bar has 10 holes in a 12-inch distance covering the center foot. A calibrated gauge dropped through each hole measures the distance from the bar to the soil surface.

A publication describing the instrument is planned.

Small Experimental Watersheds

Three small mountain watersheds (1.73, 1.24, 1.77 acres in size) have been instrumented and the calibration period begun on a study designed to test the effect of (1) pine seed-tree cutting plus hardwood deadening and (2) pine seed-tree cutting, hardwood deadening, and seedbed preparation burning upon surface runoff and erosion. The small watersheds are used in this study as large, natural runoff plots.

Installation consists of 15- x 6-foot long approach sections with 3-H type sheet metal flumes. Portable waterstage recorders will be used and sediment determinations made from water samples taken by use of the Coshocton wheel. The approach section floors were made with concrete and walls with concrete blocks 4 inches thick; the inside facing was waterproofed. Total material costs for the three approach sections plus materials for setting the flumes amounted to approximately $200.00.

Soil Moisture-Hardwood Removal

The removal of understory hardwoods has benefited shortleaf pine growth for the past two years in north Arkansas. In 1958 pine growth was one-fifth greater on plots where understory hardwoods were removed as compared to plots where hardwoods remained. This growth differential (through September) was even greater in 1959. The more favorable growth on plots which had no hardwoods was attributable to the better soil moisture conditions during dry periods.

Oxford Research Center

Small Experimental Watersheds

Further analysis of runoff and rainfall data for 1958 from nine small watersheds in north Mississippi showed additional points not mentioned in our March 1959 semiannual report.

Peak flows within each of the cover types varied directly with the amounts of storm runoff. On the basis of similar soils, the peaks from the hardwood sites were always less than half the peak discharges from the old-field, even when the total amounts of runoff were similar. Flows from the pine watersheds occurred only from very intense rains and the peaks were lower than from the other cover types.

Sediment production was low from the three cover types--all less than 0.5 ton per acre per year. Soil losses were highest from the old fields and insignificant from the pine plantations.

Soil moisture records from these watersheds indicated that surface runoff is strongly correlated with storage opportunity in the 0- to 6-inch layer of soil at the time of rain. A logarithmitic expression was developed to describe this relationship for one of the old-field watersheds with loess and Coastal Plain soils. As antecedent storage approaches zero percent of the total rainfall amount, the maximum runoff expected for the soil-cover complex may be as much as 30 percent of the rainfall. Because of the high transmission rates of the Ruston-Providence soil the bulk of most storms will percolate to lower depths. As storage opportunity increases to about 40 percent of the total storm, most of the rainfall will move into the soil and runoff will be low.

For a test, the antecedent storage-rainfall-runoff relationship developed for one watershed was used to predict runoff for the other watershed with similar soils. Actual runoff for the period of record amounted to 3.39 area inches as compared with a predicted 2.98 inches. Greatest accuracy was obtained with the winter storms. Average deviation between predicted and actual runoff for the storms of November through February was .042 inch as compared with a mean deviation of .082 inch for all storms. Although the greatest errors occur with the summer storms, the differences between predicted and actual were not significant either within seasons or for the entire period.

Vicksburg Research Center

In March 1959, the Corps of Engineers notified the Southern Station that funds for the Center would be cut in half for F. Y. 1960, and that the work would be closed out during 1961. A joint plan was developed for the completion of pending studies and reports and orderly reduction in the research program. With the aid of some fast work by the Washington Office and the field stations, the immediate needs for personnel placement were met. Center Leader Hubert Burke transferred to the Northeastern Station as Center Leader at Warren, Pennsylvania. Louis Andrew transferred to Region 8 for soil survey work. Roger Rich transferred to the center at Nacogdoches, Texas, to begin forest game habitat work. Teruo Yamamoto is scheduled to transfer to the Hawaii Research Center of the Pacific Southwest Station on a cooperative project on tropical soils. Forest Stearns remains at Vicksburg as Center Leader, with Arthur Krumbach and John Bassett as Project Leaders.

Four major projects remain in the Vicksburg Program: (1) soil strength in relation to texture and depth to water table, (2) soil strength of freezing and thawing soils (to be done in cooperation with Michigan State University and the Lake States Station), (3) transition dates and ecological analogues, and (4) moisture and strength of tropical soils (to be done in Hawaii).

During the summer, the Vicksburg Center made up a complete set of tables for converting Colman unit readings, including the San Dimas alignment chart for temperature correction of moisture readings. The question has been raised as to whether these bulky tables should be reproduced in sufficient quantity to make them more generally available in permanent form. The Southern Station would appreciate a note from each forest and range experiment station indicating an opinion as to whether the tables should be published and how many copies the station would need if the information is published.

9171

Memorandum

U. S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
WASHINGTON 25, D. C.

To : Director, All Stations (also AL)

1380 (4300)
Date: March 10, 1960

From : Herbert C. Storey, Director, Division of Watershed Management Research

Subject: Reports (Semiannual)

Our survey of stations has again brought out a strong expression in favor of continuing the semiannual report of the Division of Watershed Management Research. However, many stations had good suggestions on how the report might be improved. I shall include those suggestions in the comments which follow.

The watershed management research section of the Forest Service Manual expresses quite well in 4312.2 the intent of the report and the kind of material expected. Although the manual calls for a progress report, I interpret this to mean progress in research development rather than program accomplishment. This would include research results insofar as they are new, significant or have a bearing on research concepts and development. The semiannual report is intended to help each watershed research worker do his job better by making available to him the experiences, ideas, methods and approaches of others working on similar problems.

But I would remind each research man that this report will be most successful if he gives to it as much or more than he takes from it. One comment was made that from several appeals made through the semiannual report for comments or ideas on problems, no response was made by anyone. Maybe there were no ideas in these cases but I urge each man to give his comments if he has something worthwhile to say.

Some of the comments suggested that the reports contained extraneous material, that there seemed to be competition between stations on who could write the most and that stations felt compelled to send in material whether or not they had anything to say. The most frequently voiced suggestion was to delete reports on elections to office, meetings attended, numbers of visitors, speeches delivered, weather, and the details of routine projects of local significance. I agree that these kinds of items, although interesting to some of us, are not pertinent to the purpose and intent of the semiannual report and they should not be included in future reports.

There probably is a tendency in all of us to put off the report until due date, and this may account for some of the verbiage and insignificant material. The due date has no significance except for processing and I believe we would have a better report if we prepared our material as it comes to mind rather than making a special job of it at the time of the due date.

(Over)

It was proposed that the stations' contributions to the report be edited in the Washington Office. Probably we could organize and sharpen up the report somewhat by doing this, but we think it would also partially defeat the opportunity for the men to express themselves freely without the confounding effects of someone else's interpretation. Furthermore, I believe that with each station's material indexed, it is not too difficult to find specific items. We would prefer not to play the role of editor.

One station stated the report was too detailed and too lengthy and it was difficult to ferret out points of value; each work center should be limited to one page of the report. I have already proposed reducing the length by eliminating the "fat." As to details, I would encourage a research man to include as much detail as he deems necessary to make his story clear, whether he is reporting results, explaining a design or instrument or sending out an SOS for help on a knotty problem. I am definitely not in favor of limiting space so long as we stick to pertinent material.

It was suggested that we revise the cover page. Maybe we should, and we will work on it here. Also, it was proposed that the physical size of the report be reduced by printing on both sides of the paper. I suggest that all stations do this.

One station commented again on limiting distribution of the semiannual report. It is our feeling that the report should get no outside distribution except an occasional, well chosen individual such as another research worker. For example, we give <u>one</u> copy to Louis Glymph, Chief of the Watershed Technology Research Branch of ARS, but we have refused many other requests for the report.

In their replies to my memorandum several of the stations revealed how they use the semiannual reports. For whatever ideas you may get from them, some of their statements are quoted below:

> We use the semiannual report to keep abreast of studies at other Centers. Many of the projects so reported never appear in final print and without the semiannual report a great many useful ideas would be withheld from other Forest Service workers. Often similar lines of research are strengthened by comparison with preliminary data on experience reported elsewhere, and new ideas prompt discussion and invite comment on matters which otherwise our workers would know little about. We use back copies as a training vehicle for new workers inasmuch as reviewing the reports familiarizes a new man with research trends and results and affords handy reference to the less well known short-term studies. Preparation of any such report on deadline may sometimes seem a nuisance but we feel that the important uses served by this one more than offset any difficulties in preparing it.

* * * * * * * * *

Section 4312.2 FSM enumerates items and types of material included in the report. In addition the report serves us as:

1) It is an excellent training tool in effective writing for the younger man. We regard this as an acid test of mastery of the subject.

2) It facilitates the writing of manuscripts and other periodic reports.

3) It is the only place where a new man at the Station or Research Center can readily obtain a good background of the research program. Station Annual Reports, Project Status Reports and Hydraulic Research in the U.S. do not satisfy this need.

4) It is one of the most used working tools in our library. We value this report so highly copies are bound.

5) It avoids the tendency of having our thinking fall into ruts. It provides fresh viewpoints and opportunities to attack new processes.

6) Copies are either sent or routed to all Centers and Divisions. We feel it is one of the best mediums for informing fellow researchers at our Station about watershed problems, programs, method of study, expected results and plans for publication.

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In this era of rapid technological advance, new equipment and ideas are developed constantly. Many, if not most, of these developments are made in completely disassociated fields and forest researchers will pick them up only by accident. We must maintain our intraservice contacts so that an individual is not limited to just his own accidental findings but can benefit from those of others. Occasionally one stumbles across a new development for which he has no immediate use; a reference to it in the semi-annual report, however, may solve someone else's technique problems, or help explain some baffling findings.

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Our men have picked up hints of techniques that we have incorporated in our studies. In several cases they have written to Stations where similar work has been done and have received helpful suggestions. The informality of the report permits expression of new ideas and asking for suggestions on new problems. To some extent it takes the place of a general meeting of all Watershed Management Research personnel by furnishing a medium for exchanging of ideas.

/Herbert C. Storey